

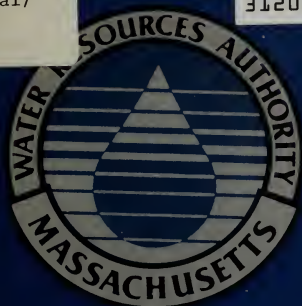
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Secondary Treatment Facilities Plan

**VOLUME I
EXECUTIVE SUMMARY**

**Final Report
March 31, 1988**



Secondary Treatment Facilities Plan

**VOLUME I
EXECUTIVE SUMMARY**

**Final Report
March 31, 1988**

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Notice To Reviewers

Attached for your review is the final report of Volume I, Executive Summary, Secondary Treatment Facilities Plan.

This document has been revised to reflect comments received during the review period for the draft report. A summary of the comments and responses will be included in Volume VIII, Public Participation and Responsiveness Summary, which will be distributed in April.

This document has received MWRA staff review but has not been accepted by the Board of Directors. The final report is being circulated at this time to seek additional public comment. The report will be submitted to the Board when the public review process is completed.

Daniel K. O'Brien
Acting Director
Engineering Division
March 31, 1988

**READER'S GUIDE TO VOLUME I
OF THE
SECONDARY TREATMENT FACILITIES PLAN**

The Secondary Treatment Facilities Plan is organized into eight volumes.

The major components of the Secondary Treatment Facilities Plan are: Treatment Plant, Inter-Island Conveyance System, Effluent Outfall, and Early Site Preparation.

The Secondary Treatment Facilities Plan document consists of a stand-alone volume for each of these components as well as volumes for Facilities Planning Background, Institutional Considerations, Executive Summary, and Public Participation and Responsiveness Summary.

Each volume may be referenced to find complete planning information pursuant to that project component. The eight volumes are numbered as follows:

Volume I	Executive Summary
Volume II	Facilities Planning Background
Volume III	Treatment Plant
Volume IV	Inter-Island Conveyance System
Volume V	Effluent Outfall
Volume VI	Early Site Preparation
Volume VII	Institutional Considerations
Volume VIII	Public Participation and Responsiveness Summary

Volume I, Executive Summary includes the following seven sections:

- 1.0 Introduction
- 2.0 Facilities Planning Background
- 3.0 Treatment Plant
- 4.0 Inter-Island Conveyance System
- 5.0 Effluent Outfall
- 6.0 Early Site Preparation
- 7.0 Institutional Considerations

Each section corresponds to a specific volume of the facilities plan.

The draft report of Volume I was issued for comments on November 13, 1987. Many valuable comments and suggestions were received and incorporated into this final report. All comments and responses to comments are included in Volume VIII. The major changes incorporated in the final report are as follows:

Section 5.0 Existing Conditions which is common to Volumes II, III, IV, and VI, has been modified to clarify plans for transporting workers, equipment, and materials in order to be consistent with mitigation commitments for busing, ferrying, and barging. The air quality

section has been expanded to include a discussion of allowable ambient levels of air pollutants and other criteria as set by the Department of Environmental Quality Engineering. The third area of revisions to Section 5.0 is a more complete description of the Historical and Archaeological Resources on Deer Island.

In Section 6.0, Flows and Loads, which is common to Volumes II and III, the major changes include clarification of the method used to estimate infiltration and inflow (I/I), and a discussion of the Authority's plans for I/I reduction. None of the estimates of flows and loads presented in the draft report have changed.

Changes in Volume III, Treatment Plant, include clarification of the expected performance of the proposed treatment facility under sustained maximum flow and load conditions; incorporation of dechlorination in the recommended plan based on the results of the whole effluent toxicity testing; and the discussion of air emissions control facilities has been expanded to further describe the recommended system and associated mitigation commitments.

Section 11.0 of Volume III describes the recommended base plan for the secondary treatment facilities. A new Section 12.0, Alternate Plan has been incorporated in Volume III to present an accelerated schedule in which the construction and operation of a portion of the secondary treatment facilities prior to 1999 is evaluated. Section 12.0 identifies the differences between the base plan and the alternate plan. The associated impacts on water quality are presented in a new Section 9.0 of Volume V.

In the draft report of Volume IV, the inter-island conveyance system was designed for phased operation in order to receive wastewater from the existing Nut Island primary treatment plant in March, 1995 and discharge it directly to the new effluent outfall system. As discussed in Volume V, the new effluent outfall system is not scheduled to be completed until late 1994 to mid-1995. Therefore, phased operation was dropped from consideration. However, the inter-island conveyance system will be completed and available for start-up in December 1994, in accordance with the court-ordered implementation schedule.

In Volume V, Effluent Outfall, a clarification has been made regarding the description of outfall siting evaluation and impact assessments. Specifically, the description of the biological impact assessment leading to a recommended plan has been changed to reflect the fact that only existing biological data was used in the site evaluation process. The detailed impact assessment described in this volume was conducted only for the recommended use and alternate plans. Additionally, there is a discussion on the interpretation of EPA Water Quality Criteria and Massachusetts Water Quality Standards.

The results of the assessment of the ability of a site to meet EPA Water Quality Criteria has been revised to reflect new ambient water quality data in Section 7.0 of Volume V. Additionally, the assessment of the ability of a site to meet Massachusetts Water Quality Standards has been revised to reflect an updated analysis technique.

Section 8.0 of Volume V has been revised to reflect additional data collected during the period between the draft and the final versions. Specifically, analyses of effluent toxicity,

bioaccumulation potential, and the effects on primary productivity have been added.

In Volume VI, Early Site Preparation, the recent declaration by the Massachusetts Department of Capitol Planning and Operations (DCPO) that it is unlikely that the Deer Island House of Corrections will be decommissioned before the end of 1991, and then only if special legislation allows DCPO to construct a new prison on a design/build basis, is reflected. A more detailed evaluation of potential noise impacts and recommended mitigation measures resulting from the implementation of early site preparation activities with an operating prison is included.

The traffic impact analyses contained in this Volume have used the revised traffic data as the basis against which to project impacts. These revised traffic analyses clarify plans for transporting workers, equipment, and materials to Deer Island in accordance with mitigation commitments made during the Siting FEIS process and recent negotiations with the Town of Winthrop.

Section 7.0 of Volume VII has been revised to incorporate MWRA's concerns relating to bond coverage and the current, approved CIP program. The capital costs associated with the treatment facilities have been updated to reflect the latest costs included in Volume III.

At the time of the issuance of the draft report, MWRA had not completed their final mitigation planning. Section 10.0 has been changed to reflect the mitigation commitments MWRA has negotiated and the Memorandum of Understanding (MOU) MWRA has with Winthrop.

SECONDARY TREATMENT
FACILITIES PLAN
VOLUME I
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SECONDARY TREATMENT
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SECONDARY TREATMENT
FACILITIES PLAN
VOLUME VIII
PUBLIC PARTICIPATION
AND RESPONSIVENESS
SUMMARY

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MASSACHUSETTS
WATER RESOURCES
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DEER ISLAND
SECONDARY TREATMENT FACILITIES PLAN
VOLUME I

SECONDARY TREATMENT FACILITIES PLAN

VOLUME I

EXECUTIVE SUMMARY

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1.0 INTRODUCTION

1.1 VOLUME IDENTIFICATION

The following is Volume I, Executive Summary of the Deer Island Secondary Treatment Facilities Plan. It is the first of eight volumes and summarizes the seven subsequent volumes.

1.2 BRIEF DESCRIPTION OF PROJECT

The existing Massachusetts Water Resources Authority (MWRA) wastewater collection system consists of a North System and a South System. Currently, wastewater from the South Metropolitan Sewerage System is treated at the Nut Island Primary Treatment Plant, and wastewater from the North Metropolitan Sewerage System is treated at the Deer Island Primary Treatment Plant.

The Secondary Treatment facilities plan evaluates the facilities needed to provide primary and secondary treatment of the wastewater conveyed through MWRA's North and South sewerage collection systems at a single treatment facility to be located on Deer Island. The Facilities Plan also evaluates the facilities needed to convey the South System flows from the existing Nut Island Plant to Deer Island, and the outfall facilities needed to convey the treated effluent from Deer Island to a disposal point in marine waters.

1.3 ORGANIZATION OF THE REPORT

Each section of this Executive Summary corresponds to a volume of the Facilities Plan. A brief description of the contents of each volume follows.

Volume II, Facilities Planning Background, describes the need for the planning project and the planning approach. It summarizes previous studies for the cleanup of Boston Harbor and other harbor-related projects. It also outlines the decision making process in the siting of the new facilities, and the court-ordered dates for implementation of the Facilities Plan. Volume II describes the planning period and the service area for the facilities, projected flows and loads, and criteria used to evaluate all of the possible treatment processes in order to determine the most feasible, effective methods of treatment. The existing treatment facilities, environments, and regulations, are also examined in Volume II, as well as the environmental regulations that will affect the construction of the planned facilities.

The facilities needed to provide secondary treatment include the following: new primary and secondary treatment facilities located on Deer Island, and preliminary treatment facilities at Nut Island; a new conduit to convey the South System wastewaters from Nut Island to Deer Island (inter-island conveyance facilities); and a new outfall to discharge the treated effluent into the ocean.

The initial implementation phase of the treatment plant construction program is early site preparation. Early site preparation includes the construction activity that can start before

the completion of the on-island piers facilities. The planning for the facilities needed to provide secondary treatment and the early site preparation project are presented in four, stand-alone volumes:

Treatment Plant, Volume III
Inter-Island Conveyance System, Volume IV
Effluent Outfall, Volume V
Early Site Preparation, Volume VI

Volume VII, Institutional Considerations, identifies the permitting, program management, financing, human resources and regulatory requirements for constructing and operating the recommended facilities within the schedule entered by the Federal Court. The analysis includes a review of the court-ordered target dates and recommends the changes in the schedule that are deemed necessary.

Volume VIII, Public Participation and Responsiveness Summary, includes all comments and responses received on the draft documents as well as summary of the Public Participation Program.

2.0 FACILITIES PLANNING BACKGROUND

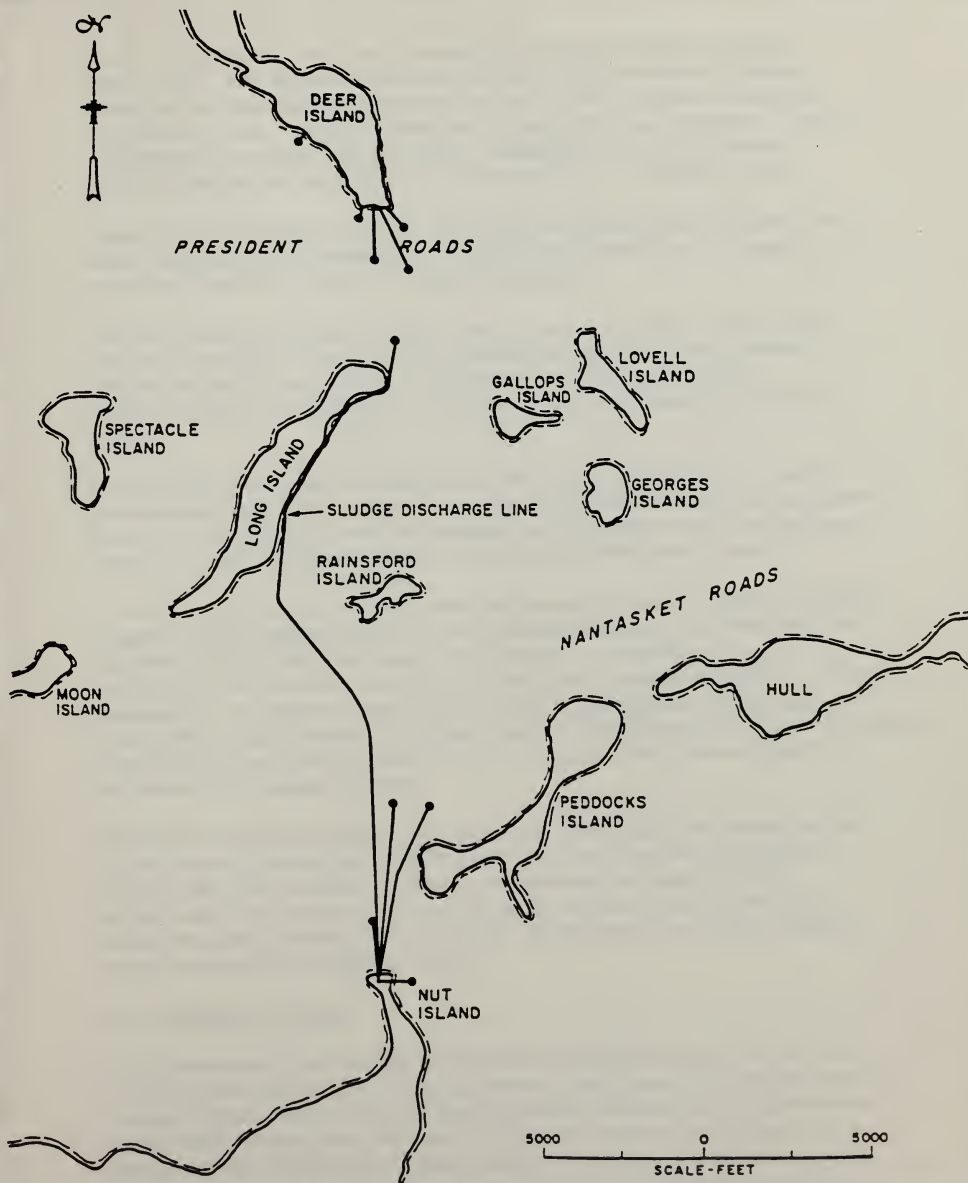
2.1 PROJECT NEED

Since the time of the Revolutionary War, Boston Harbor has been considered a national landmark. The largest seaport in New England, it supports a variety of marine activities including shipping, fishing, boating and recreation. It encompasses an area of 47 square miles bordered by residences, commercial buildings, restaurants, marinas, beaches, industries and shellfishing flats. But since the settlement of Boston's shore areas, and most particularly since the City of Boston took possession of Deer Island for "sanitary purposes" in 1847, the harbor has been the receiving water for all of the domestic, commercial and industrial wastewater and stormwater from the Boston metropolitan area.

Today, nearly 5,000 miles of sewers, conduits and pipes collect wastewater from 1.9 million people in 43 metropolitan cities and towns and transport it to the area's two wastewater treatment plants at Nut Island and Deer Island for treatment prior to discharge to Boston Harbor. Both of the plants are designed to provide primary treatment. Each plant provides disinfection of the primary effluent to reduce the levels of pathogenic bacteria prior to discharge to the harbor. The disinfected effluent from Deer Island is discharged through two diffuser-equipped outfalls measuring 4,600 and 5,400 feet in total length, and discharging into President Roads approximately 1,900-2,500 feet from the Deer Island shoreline. Two additional relief outfalls, 135 and 500 feet long, extend approximately 50 and 500 feet from the Deer Island shoreline. A fifth outfall discharges just offshore on the west shore of the island. This outfall is not used for excess flow but only if repair work is being done on the other outfalls.

The disinfected effluent from Nut Island is discharged north through two main outfalls into Nantasket Roads approximately 4,500-5,000 feet from Nut Island. During periods of high flows and/or extremely high tides a third outfall extending about 1,500 feet north into the West Gut side of Hingham Bay may be used. In addition, an emergency outfall extends 500 feet into the Hingham Bay side of West Gut.

The sludges removed at both plants are anaerobically digested and discharged into President Roads on the outgoing tide. Figure 2-1 illustrates the location of each of the treatment facilities and discharge locations. The combined discharge of primary effluent and sludge to the relatively shallow waters of Boston Harbor imposes a significant burden on the marine ecology in the waters surrounding the discharge points. The discharge of floatable materials results in a significant deterioration in the aesthetic qualities of the harbor waters. Because these discharges of wastewater and sludge are but a few of the total discharges to Boston Harbor, and because scientific research to delineate the impacts of each discharge on the harbor has been limited to date, the precise impacts of the primary effluent and sludge are difficult to quantify. However, these discharges are unquestionably very sizable and the materials being discharged are ecologically significant. Thus, every reasonable effort should be made to reduce these discharges.



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FIGURE 2-1
DEER ISLAND AND NUT ISLAND EFFLUENT
AND SLUDGE DISCHARGE LOCATIONS

The Deer Island treatment facility was constructed in 1968, and the Nut Island treatment facility in 1952. Both facilities have exceeded their useful lives and the levels of treatment provided are often less than optimal because of the unavailability of replacement equipment. Nut Island has recently undergone a rehabilitation of most of its major components. A similar rehabilitation is now underway for Deer Island. Rehabilitation of the existing treatment facilities will optimize the levels of removal that these facilities can consistently provide.

However, even the rehabilitated facilities cannot provide the levels of treatment desired. The design criteria and installed equipment of the existing primary facilities do not represent present day technology; therefore, they require replacement.

The 1972 Federal Clean Water Act requires that all municipal wastewater treatment systems incorporate secondary treatment. Secondary treatment is more complex than the primary treatment that the flows at Nut Island and Deer Island currently receive, removing significantly higher levels of both organic materials and solids from wastewater (80 to 90 percent).

Like the Federal Water Pollution Control Act, the Massachusetts Clean Water Act requires promulgation of water quality standards for waters within the Commonwealth. The Massachusetts Division of Water Pollution Control has established these standards to satisfy the requirements of both acts. Thus, both federal and state statutes require increased levels of treatment.

In 1982, the City of Quincy filed a suit against the Metropolitan District Commission (MWRA's predecessor agency) charging violations of laws prohibiting discharges into coastal waters and tidal waters, and violations of the common law of nuisance. As the suit progressed, the Massachusetts Water Resources Authority was created by the Massachusetts legislature. Almost simultaneously with MWRA's creation, the U.S. Environmental Protection Agency filed suit against MWRA alleging violations of the Clean Water Act. The Federal District Court found MWRA to be in violation and ordered the Authority to plan and construct new treatment facilities in accordance with an aggressive schedule.

The need for upgraded and expanded treatment facilities to serve the Boston metropolitan area is clear: current discharges place a significant burden on one of the area's vital natural resources; the existing treatment facilities have long exceeded their useful lives; the existing treatment facilities do not reflect present day technology and design; Federal and State statutes require enhanced levels of treatment; and the Federal Court has intervened and ordered an upgrading of the treatment facilities.

2.2 PLANNING APPROACH

This facilities planning study provides the foundation for the Massachusetts Water Resources Authority's program for the construction and operation of new primary and secondary wastewater treatment facilities at Deer Island. This planning has been approached with the understanding that the facilities planning effort must secure and sustain the acceptance and support of the diverse community, government and business interests that it affects. Therefore, the planning process was based not on technical strength alone, but also on the continual reconciliation of

political, legal, environmental, economic and community interests.

A critical component of the facilities planning for secondary treatment facilities has been completed: the siting of the new treatment facilities. On February 3, 1986, the MWRA made its final selection of a site for the proposed harbor island wastewater treatment plant. The selection of Deer Island as the location for the new facility brought to a close eight years of evaluation, discussion, comment and refinement of siting issues. Most of the history of the process, and information explored, is contained in the Supplemental Draft Environmental Impact Statement/Draft Environmental Impact Report (SDEIS/DEIR) and the MWRA's Final Environmental Impact Report on the Siting of Wastewater Treatment Facilities in Boston Harbor (FEIR).

Recognizing the need to adopt all feasible measures to mitigate the adverse environmental impacts, the MWRA, as part of the FEIR, set forth a series of mitigation commitments designed to alleviate the impacts associated with the construction and operation of the Deer Island plant. During the process of making its final siting decision the MWRA reviewed the public comments on the proposed mitigation commitments and the comments received from the Secretary of Environmental Affairs and adopted a final series of mitigation commitments. These commitments cover the following areas:

- o Flow and growth
- o Operation and maintenance
- o Noise
- o Barging and Busing
- o Use of liquid chlorine
- o Relocation of Deer Island House of Correction

The decision-making process and the mitigation commitments made during the siting process were considered to be firm guidance for the planning to be undertaken in this project.

In facing the monumental tasks associated with the successful implementation of the Deer Island Secondary Treatment Facilities Plan, the Authority instituted a comprehensive public participation effort. The measures included were designed to meet federal and state regulatory requirements associated with the project, to satisfy grant conditions, and to provide the most meaningful avenues of public input into the critical decisions to be made by the Authority. Through this program, the Authority's dialogue with the public has been ongoing and important policy decisions have been made and will continue to be made within the context of maximum public knowledge and participation.

The successful treatment of wastewaters from the Boston metropolitan area requires not only that enhanced treatment facilities be provided, but also that reliable, environmentally sound facilities be provided to manage the disposal of the residuals that are the direct by-products of wastewater treatment. The residuals management facilities plan is being conducted as a separate but concurrent study. The facilities needed and the sites being considered for residuals management are quite different from those needed for secondary treatment. However, the schedule for completion of the residuals management facilities plan is similar to the

schedule for this plan. In addition, the approach and work plans for both of these planning studies recognize the synergistic relationship of these two plans. Thus, this planning study must be read with full cognizance of the residuals management facilities planning.

To expedite the planning and review process, the facilities planning for secondary treatment has received a designation as a "major and complicated" project under the Massachusetts Environmental Policy Act regulations. The "major and complicated" project designation permits the environmental reviews to be concurrent with, and an integral part of, the facilities planning process. Thus, the documents being prepared to summarize the facilities planning are the same documents which will be used for environmental reviews.

2.3 RELATED PROJECTS

Although the Secondary Treatment Facilities Plan is the beginning of the key project in the Boston Harbor Clean-Up Program, there is a long list of projects that are being planned, designed or are under construction to upgrade and expand the MWRA's wastewater collection and treatment capabilities. These projects are grouped into the following programs:

Treatment Plant Upgrade

- Nut Island Immediate Upgrade
- Deer Island Fast-Track Improvements

Interim Residuals Management

- Interim Sludge Processing and Disposal
- Interim Scum Management

Long-Term Residuals Management

Water Transportation Facilities

Combined Sewer Overflows

Harbor Research and Monitoring

Wastewater Transport Program

In addition to the above wastewater programs, several waterworks projects have either a direct or an indirect bearing on the secondary treatment facilities planning. MWRA has also initiated several projects to strengthen its ability to direct and manage its extensive capital program and its formidable day-to-day operational responsibilities.

2.4 BASIC PLANNING CRITERIA

2.4.1 PLANNING PERIOD

The planning period used in this facilities plan encompasses the period from now through the year 2020. This represents the first twenty years of operation of the secondary plant, which has been stipulated by the federal court to be in operation not later than the end of 1999.

The use of twenty-year planning periods is considered generally accepted practice in the engineering profession, and is required by construction grant regulations issued by the U.S. Environmental Protection Agency (EPA).

2.4.2 SERVICE AREA

Under its enabling legislation, MWRA is charged with providing treatment to the wastewaters generated in 43 municipalities and special districts. The legislation permits permanent sewer service to other communities, but only after these communities have shown that no feasible alternatives exist, and after numerous regulatory and legislative approvals have been obtained.

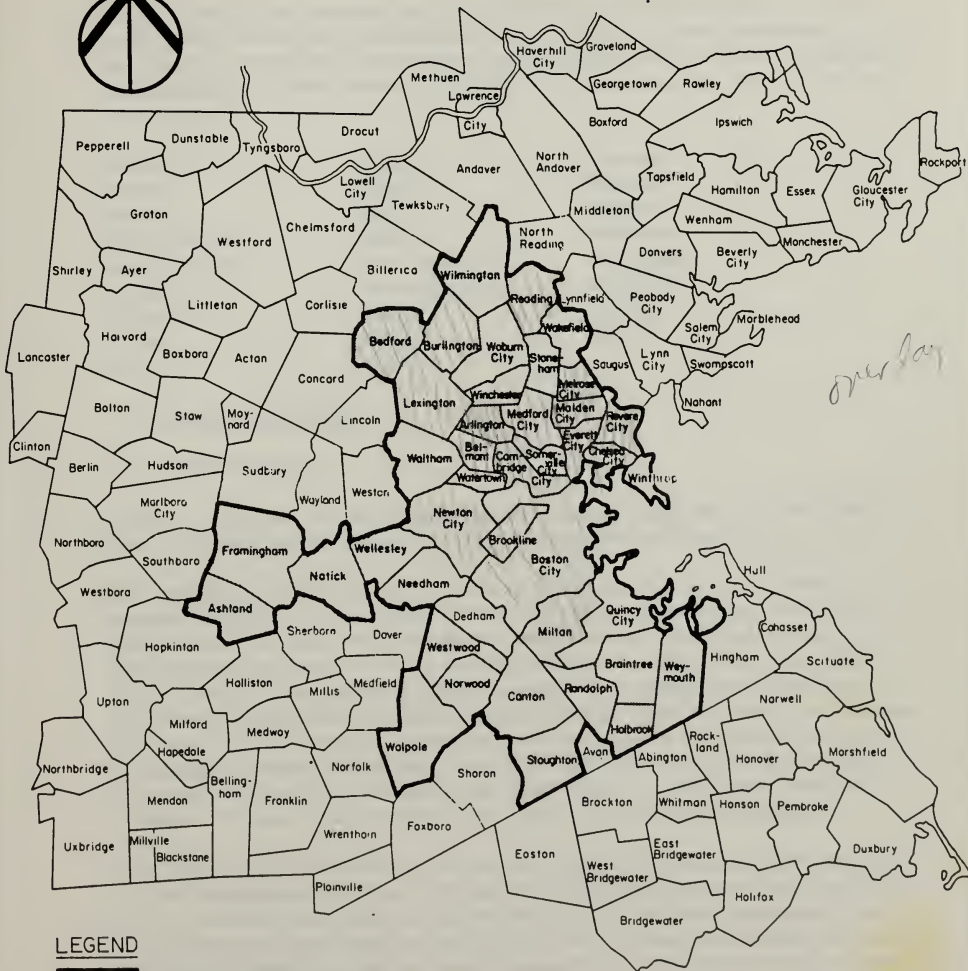
Expansion of the service area, if it takes place, will occur at the boundaries of the existing service area. Figure 2-2 shows the existing service area, together with communities which are adjacent to the boundary of the area. Most of the communities abutting the Authority's service area are already served by a wastewater system. Any system expansion which might be considered would be on a very limited basis due to existing wastewater utilities on the perimeter of the MWRA service area. Therefore, in developing population and flow projections, the existing service area was used as a base.

As mentioned, MWRA owns and operates two wastewater treatment plants, one at Deer Island and the other at Nut Island, which handle wastes from the North and South Metropolitan Sewer Service Areas, respectively. Some communities in the service area are serviced by both plants.

The Nut Island Facility (servicing the South System) presently serves the following twenty-one communities:

Ashland	Hingham (N. Sewer Dist.)	Quincy
Boston (portion)	Holbrook	Randolph
Braintree	Milton (portion)	Stoughton
Brookline (portion)	Natick	Walpole
Canton	Needham	Wellesley
Dedham	Newton (portion)	Westwood
Framingham	Norwood	Weymouth

The South System encompasses an area of approximately 240 square miles and at present has a total population of approximately 750,000 and a contributing population of approximately 630,000. Five MWRA pumping stations are located throughout the South System contributing area.



LEGEND



MWRA SERVICE AREA

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**FIGURE 2-2
MWRA SERVICE AREA**

The Deer Island Facility (servicing the North System) serves twenty-six communities. The area served by this treatment plant is approximately 170 square miles with a total population of approximately 1,300,000 and a contributing population of approximately 1,250,000. Six MWRA pumping stations are located throughout the North System contributing area. Member cities and towns include:

Arlington	Lexington	Stoneham
Bedford	Malden	Wakefield
Belmont	Medford	Waltham
Boston (portion)	Melrose	Watertown
Brookline (portion)	Milton (portion)	Wilmington
Burlington	Newton (portion)	Winchester
Cambridge	Reading	Winthrop
Chelsea	Revere	Woburn
Everett	Somerville	

2.5 EXISTING FACILITIES

2.5.1 NORTH SYSTEM

Currently, influent flow from the North Metropolitan Sewerage System enters the Deer Island Plant through the Main Pumping Station and the Winthrop Terminal Headworks.

Flow entering the plant through the Main Pumping Station receives preliminary treatment, consisting of screening and grit removal, at one of the three remote headworks: Chelsea Creek, Ward Street, and Columbus Park. Effluent from each headworks is discharged to a vertical shaft, then conveyed through one of two deep rock tunnels to the Main Pumping Station at Deer Island. The first tunnel, the Boston Main Drainage Tunnel, is approximately 7 miles long. It crosses under Boston Harbor from Deer Island to South Boston where it connects to the Columbus Park Headworks. The Boston Main Drainage Tunnel continues from Columbus Park to the Ward Street Headworks located off Huntington Avenue, near the Wentworth Institute of Technology. The second rock tunnel, the North Metropolitan Relief Tunnel, is approximately 4 miles long. It connects the Chelsea Creek Headworks to the Main Pumping Station at Deer Island.

The Winthrop Terminal Headworks screen and pump influent flow that arrives at Deer Island via the North Metropolitan Trunk Sewer. This sewer is the original interceptor to Deer Island and is roughly paralleled by the North Metropolitan Relief Tunnel. The North Metropolitan Trunk Sewer receives flows from Winthrop, Orient Heights, and Deer Island, and overflows from the Chelsea Creek Headworks via the East Boston Pumping Station. The North Metropolitan Trunk Sewer has a peak capacity of 125-mgd. The Winthrop Terminal was designed to screen this entire flow and to provide grit removal for 60-mgd. Flows receiving grit removal are discharged to the primary plant. Flows in excess of the capacity of the grit system are discharged directly to the Deer Island Plant bypass.

The North System components are shown schematically in Figure 2-3. During peak flows, normally caused by wet weather flows from the numerous combined sewers of the North Metropolitan System, the Boston Main Drainage and North Metropolitan Relief Tunnels are selectively throttled at the three remote headworks, thereby diverting flows in excess of the plant's capacity to CSOs.

The existing primary wastewater treatment plant at Deer Island was designed to treat an average flow of 343-mgd and a peak flow of 848-mgd. Influent flow from the Main Pumping Station and Winthrop Terminal Headworks are discharged to two preaeration channels. Primary treatment is provided by eight sedimentation tanks. Effluent from the primary tank is then chlorinated and discharged to the harbor through a series of outfalls.

Primary sludge, grease, and scum is collected, thickened, and pumped to anaerobic digesters. Digested sludge, and bypass flows from the Winthrop Terminal, are mixed with the primary effluent prior to discharge to the harbor.

A schematic of the Deer Island Wastewater Treatment Plant showing the flow pattern and the arrangement of treatment units is presented in Figure 2-4.

2.5.2 SOUTH SYSTEM

The South Metropolitan Sewerage System consists of a network of approximately 78 miles of MWRA interceptor sewers, five pump stations which are owned and maintained by the MWRA, and the existing Nut Island treatment plant. There are no remote headworks on the South Metropolitan Sewerage System.

The High Level Sewer (HLS) conveys wastewater from the South System to the Treatment Plant in Quincy. It begins in the Parker Hill section of Roxbury, just south of the North Metropolitan System's Ward Street Headworks, and extends, about 15 miles, through Hyde Park, Milton and Quincy to the Nut Island Plant. Along the sewer route, major flows are received from MWRA extension sewers including the Brighton Branch, Neponset Valley Sewer, Upper Neponset Valley Sewer, New Neponset Valley Sewer, Wellesley Extension Sewer, and the Wellesley Extension Relief Sewer.

Main components of the South Metropolitan System are shown in Figure 2-5.

The Nut Island Wastewater Treatment Plant provides screening, grit removal, preaeration, primary sedimentation and disinfection. Plant effluent is discharged to the harbor. A schematic of the plant is presented in Figure 2-6.

2.6 EVALUATION CRITERIA

As part of the Secondary Treatment Facilities Plan development, major decisions were made to select a wastewater treatment process; to size and locate conduits and pumping stations to

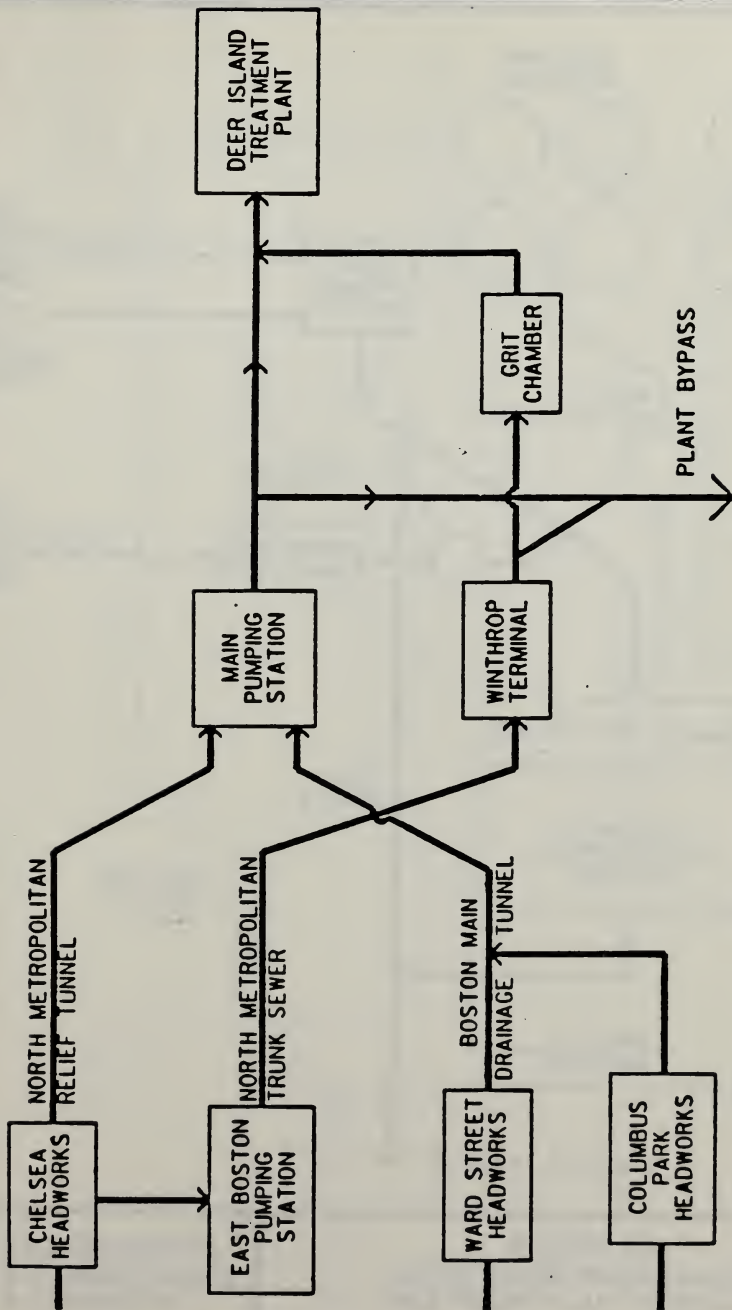
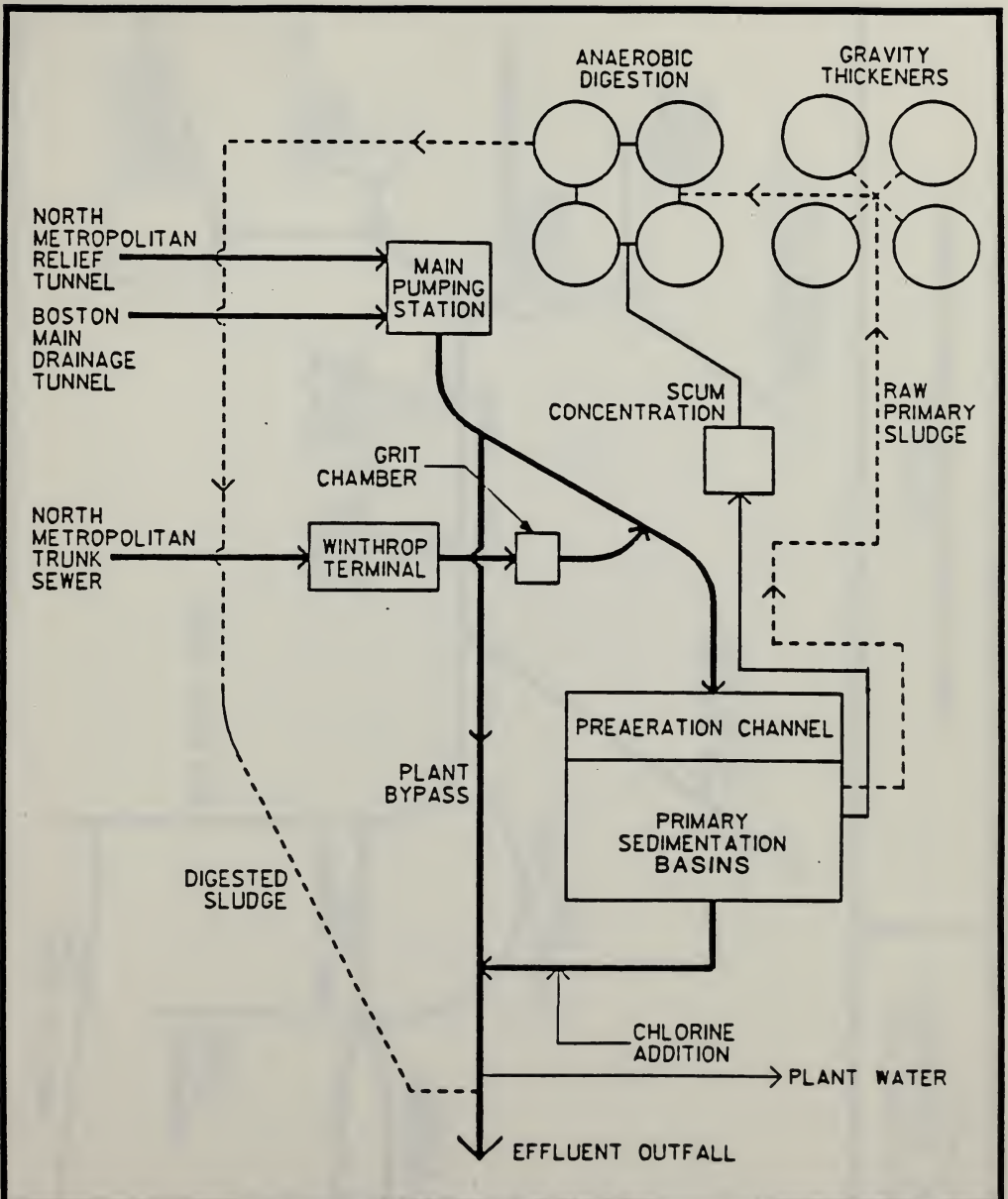


FIGURE 2-3
NORTH SYSTEM HEADWORKS AND TUNNEL SCHEMATIC

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FIGURE 2-4
DEER ISLAND WASTEWATER
TREATMENT PLANT SCHEMATIC

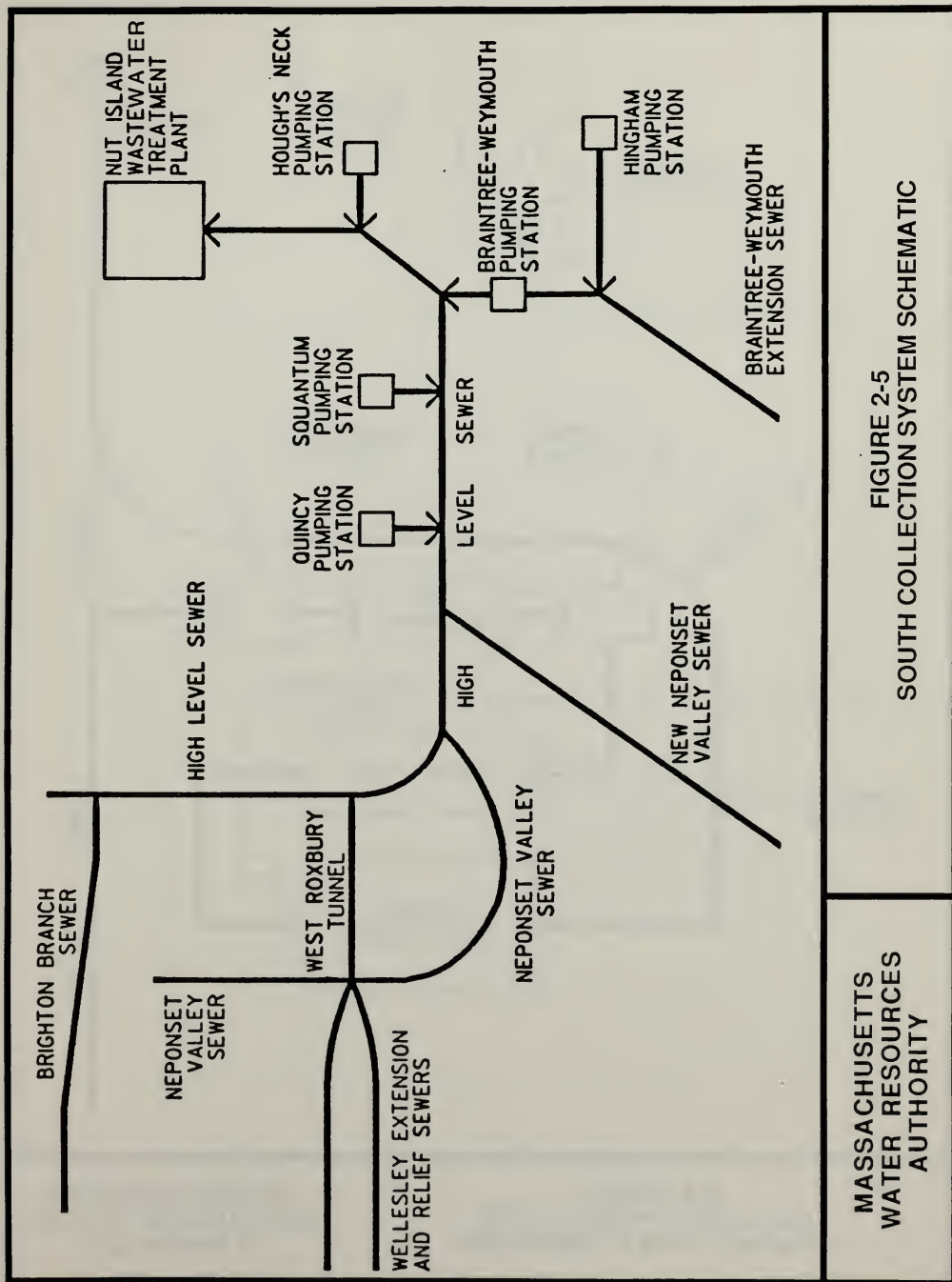
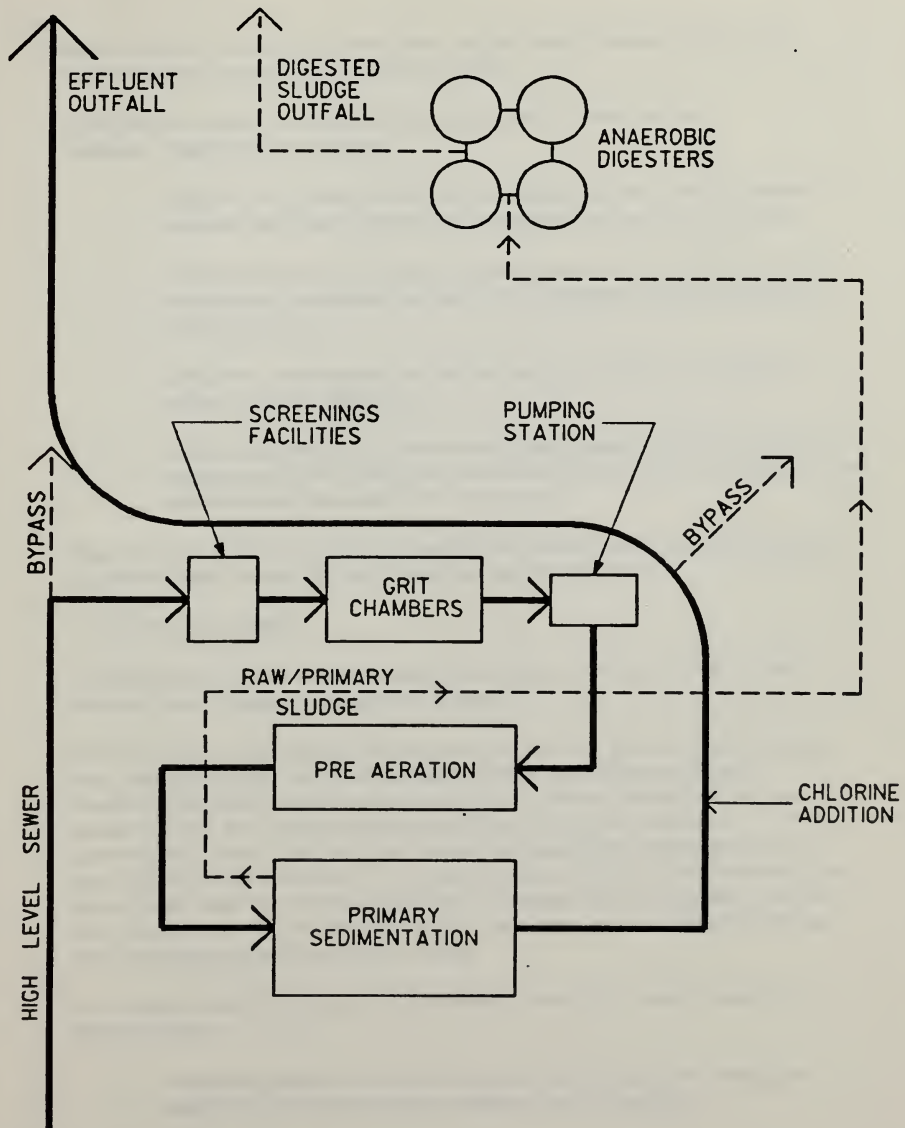


FIGURE 2-5
SOUTH COLLECTION SYSTEM SCHEMATIC

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FIGURE 2-6
NUT ISLAND WASTEWATER
TREATMENT PLANT SCHEMATIC

convey wastewater to, and treated effluent from, the Deer Island Treatment Facility; and to plan the initial site preparation program at Deer Island.

In evaluating the various alternatives, four broad categories of criteria have been established. These include the following:

- o Environmental Criteria, which focus on air emissions, noise, traffic and marine resources, and measure the potential environmental impacts of each alternative;
- o Technical criteria, which focus on engineering issues such as reliability, flexibility, constructibility, operational complexity, area requirements, staffing requirements, and power needs;
- o Cost criteria, which present the financial investment necessary to construct and operate the various alternatives;
- o Institutional criteria, which assess the differences among alternatives according to the time required for construction and the coordination required among a wide variety of public and private organizations and agencies.

These criteria were used to select the recommended plan, which provides the most technically and environmentally sound, cost-effective and implementable alternative.

2.7 FLows AND LOADS

Of initial importance in the sizing and design of the wastewater treatment facilities are the estimated flows and loadings expected at the facilities.

The wastewater and associated pollutants received at the MWRA's treatment facilities originate from a variety of sources: domestic wastewater associated with residential activities; nondomestic wastewater associated with the commercial, industrial, institutional, and other business activities of the region; infiltration and inflow (I/I); and stormwater flow. Infiltration and inflow is water other than domestic and nondomestic wastewaters that enters sewers unintentionally, and results from the age, condition and location of the more than 5,000 miles of public sewer pipe tributary to the MWRA's treatment facility. Stormwater flow is the flow that results from the combined systems which carry both wastewater and street drainage, and is intentionally allowed into the sewer system.

The volume of wastewater produced in the Authority's service area is directly related to the following factors:

- o the sewered population of the service area and the volume of water used by the residents and returned to the sewer system as domestic wastewater;

- o the economic activity taking place within the service area which drives area growth and employment and thus the volume of nondomestic wastewater discharged as a result of commercial, industrial, manufacturing and employee usage; and
- o the rainfall in the service area, which enters the sewer system as I/I or as direct stormwater flow, and the groundwater levels in the service area which, when high, add to the volume of I/I.

The total domestic and nondomestic wastewater flows will average about 239 mgd by the year 2020. This assumes a total domestic wastewater flow of 136 mgd based on a service area population of 2.1 million in the design year, and total nondomestic wastewater flow of 103 mgd. I/I and direct stormwater runoff account for a significant amount of flow in the MWRA sewer system. Seasonal flow variations have been documented and are a direct response to variations in I/I. The spring months have notably higher flows than the remainder of the year due to higher groundwater elevations which result in increased I/I. Due to this phenomenon, I/I flows were estimated for two periods: high groundwater conditions (normally February - May); and low groundwater conditions (normally June - January). Average I/I is expected to vary from approximately 150 mgd to 430 mgd.

Annual nonstorm flow to the plant in the design year is expected to average 480 mgd, based on average flow of 390 mgd during low groundwater conditions and 670 mgd during high groundwater conditions.

Within the communities of Boston, Brookline, Cambridge, Chelsea and Somerville (exclusively in the North System) are approximately 12,900 acres with combined sanitary and storm sewers. During storms, runoff reaches the plant via these combined sewers. Stormwater runoff in excess of the transmission capacity of the sewer system is discharged to nearby water bodies as combined sewer overflow (CSO). The maximum capacity for headworks receiving stormwater runoff, and for the proposed headworks at Nut Island serving the South System service area, is shown below.

Transmission System Capacity (mgd)

Ward Street	256
Columbus Park	182
Chelsea Creek	350
Winthrop Terminal	<u>125</u>
Subtotal North System	913
Subtotal South System	<u>360</u>
TOTAL	1,273 (rounded to 1,270 in subsequent tables)

Maximum daily non-storm flows will range from 600 mgd to 950 mgd depending on the time of the year. Since the maximum hydraulic capacity of the transport system is approximately 1,270 mgd, from 320 to 550 mgd of capacity is available to accept stormwater flows in the North System at maximum day wastewater flow conditions.

Recent proposals for CSO management envision storage and pumpback of storm flows to the plant. These additional flows are planned to range from 200 to 300 mgd over a period of one to two days. The flow projections used for this study include ample capacity for pumpback of stored CSO.

A summary of the projected flows (rounded to the nearest 10-mgd) are presented in Table 2-1. Figure 2-7 summarizes the design year flow, by components, for low and high groundwater conditions.

Treatment plant loadings have been described in terms of two general categories: conventional pollutant loadings and non-conventional pollutant loadings. Conventional pollutants, defined as Biochemical Oxygen Demand (BOD) and Total Suspended Solids (TSS) are parameters commonly used to define wastewater strength.

Estimates of future year average annual conventional pollutant loadings were developed using two steps. First, the current plant loadings were ascertained from historical records and sampling data collected as part of the Facilities Plan. Second, loading allowances were made for the capture of existing dry weather overflows and CSO management as well as allowances for increased solids contributed to the plant as a result of growth in domestic and nondomestic flows. Additional loadings equaling 10 percent of the influent loads were included as an allowance for sidestreams from sludge processing in the sizing of individual wastewater treatment unit processes.

Estimates for conventional pollutant loads from stormwater were developed by analyzing pollutant mass accumulation over the combined sewer service area. The accumulation of pollutants on the land is primarily a function of land use and time between storms. During a major storm event, runoff carries pollutants on the land surface into the combined sewer system. After the storm event, the mass of pollutants begins to accumulate again. The accumulation continues until the next storm event when all or some of the pollutant mass is carried by runoff to the combined sewer system.

Table 2-1 presents estimated design year BOD and TSS loadings.

The wastewater sampling program conducted in the fall of 1986 and the spring of 1987 characterized the existing non-conventional pollutants loading at Nut Island and Deer Island Treatment Facilities. A summary of the results of the sampling program for metals, acid base neutrals, and VOAs is shown in Tables 2-2 through 2-4. No pesticides or PCBs were detected in any of the samples.

TABLE 2-1

DESIGN YEAR (2020) FLOWS AND LOADS

LOW GROUNDWATER CONDITIONS HIGH GROUNDWATER CONDITIONS

	<u>Average Day</u>	<u>Maximum Day</u>	<u>Peak Hour</u>	<u>Average Day</u>	<u>Maximum Day</u>	<u>Peak Hour</u>
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NON-STORM CONDITIONS

Total Flow (mgd)	390	600	750	670	950	1000
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STORM CONDITIONS

Wastewater Flow (mgd)	390	600	750	670	950	1000
Storm Capacity (mgd)		<u>550</u>	<u>510</u>		<u>320</u>	<u>270</u>

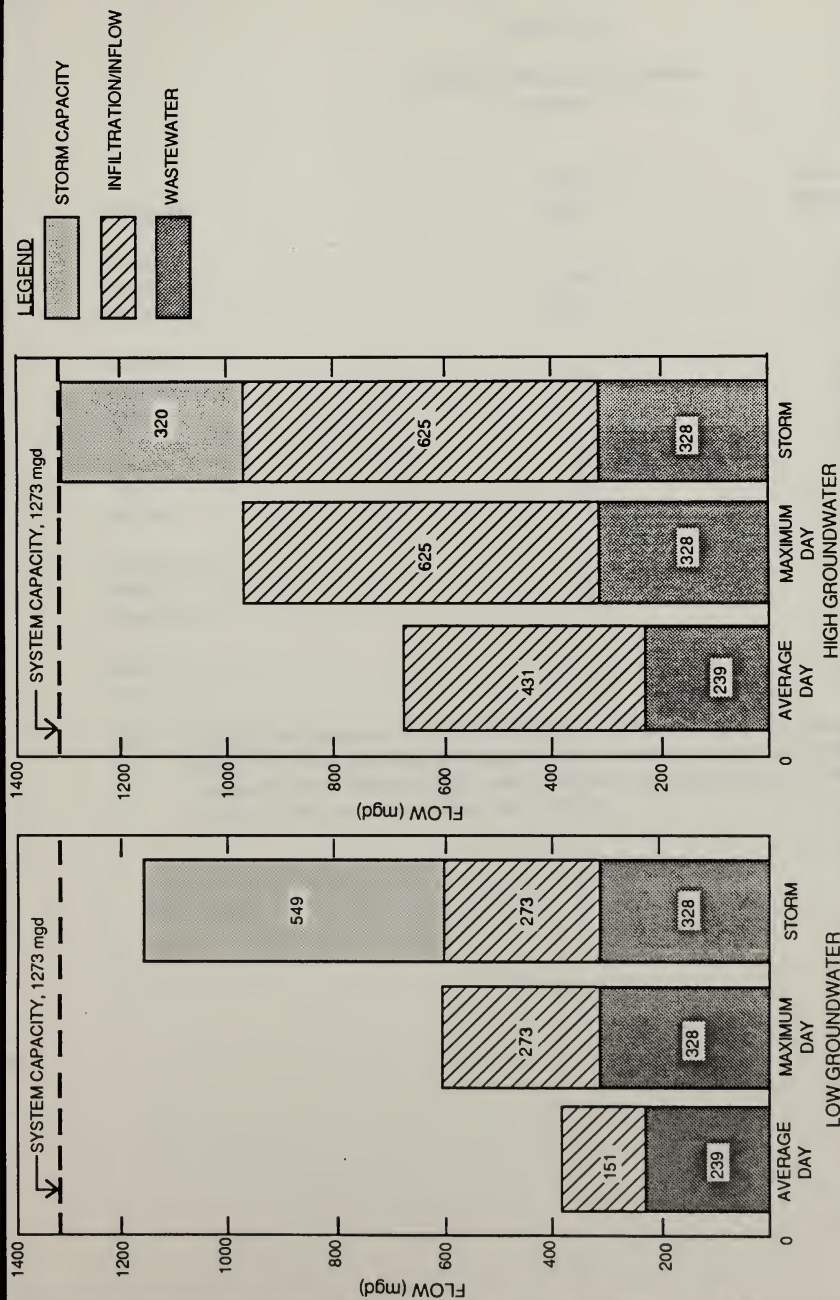
Total Flow (mgd)		1150	1260		1270	1270
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(Annual Average Flow is 480 mgd based on 4 months of high groundwater conditions and 8 months of low groundwater conditions.)

Loads (1000 lbs/day)

	<u>BOD</u>	<u>TSS</u>
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Average Day	570	515
Maximum Day	1140	1080
Maximum Three Days	855	824
Maximum Month	741	670
Maximum Day with Storm	1305	1480



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FIGURE 2-7
SUMMARY OF DESIGN YEAR FLOWS AND LOADS

TABLE 2-2
EXISTING METAL LOADINGS
(lbs/day)

<u>Constituent</u>	<u>Average Load</u>	<u>Standard Deviation</u>
Antimony	10.8	2.3
Arsenic	6.0	1.9
Boron	1261.2	2443.4
Cadmium	7.1	2.7
Chromium	75.8	29.5
Copper	345.1	103.4
Cyanide, Total	53.9	13.9
Lead	49.9	21.8
Mercury	4.1	5.2
Molybdenum	17.1	10.4
Nickel	66.0	29.5
Selenium	35.2	33.2
Silver	15.5	3.8
Zinc	738.8	841.8

Note: Average Load represents the non-storm mean load at Deer Island plus the non-storm mean load at Nut Island. Loadings are based on influent values only, which are reported in Summary Memorandum FB20C, and are the result of sample collections at the headworks for Deer Island, and Deer and Nut Island Influent.

TABLE 2-3
EXISTING ABN LOADINGS
(lbs/day)

<u>Constituent</u>	<u>Average Load</u>	<u>Standard Deviation</u>
Phenol	54.0	27.1
Benzyl Alcohol	69.3	24.7
1, 2-Dichlorobenzene	65.1	23.3
2-Methylphenol	71.0	18.3
4-Methylphenol	61.2	23.2
Benzoic Acid	269.4	138.9
Naphthalene	45.3	28.4
2-Methylnaphthalene	49.6	26.7
2, 4, 5-Trichlorophenol	349.0	95.8
Dimethyl Phthalate	69.6	19.4
Diethyl Phthalate	57.1	24.5
N-Nitrosodiphenylamine (1)	69.3	19.7
Di-n-butyl Phthalate	57.9	25.9
Butylbenzyl Phthalate	54.0	24.1
Bis (2-ethylhexyl) Phthalate	67.8	20.0
Di-n-octyl Phthalate	57.0	21.4

Note: Average Load represents the non-storm mean load at Deer Island plus the non-storm mean load at Nut Island. Loadings are based on influent values only, which are reported in Summary Memorandum FB20C, and are the result of sample collections at the headworks for Deer Island and Deer and Nut Island Influent.

TABLE 2-4
EXISTING VOLATILE LOADINGS
(lbs/day)

<u>Constituent</u>	<u>Average Load</u>	<u>Standard Deviation</u>
Bromomethane	54.3	19.3
Methylene Chloride	104.7	75.3
Acetone	337.1	268.6
Carbon Disulfide	27.5	7.6
trans-1,2-Dichloroethene	25.6	7.8
Chloroform	17.6	8.1
2-Butanone	82.5	43.8
1,1,1-Trichloroethane	41.8	17.9
Trichloroethene	36.2	19.2
Benzene	12.5	2.3
4-Methyl-2-Pentanone	64.7	23.7
Tetrachloroethene	47.4	27.8
1,1,2,2-Tetrachloroethane	29.4	6.4
Toluene	60.8	38.1
Chlorobenzene	28.0	7.6
Ethylbenzene	28.8	13.0
Styrene	30.1	7.3
Total Xylene; M, O, and P	85.9	59.4

Note: Average Load represents the non-storm mean load at Deer Island plus the non-storm mean load at Nut Island. Loadings are based on influent values only, which are reported in Summary Memorandum FB20C, and are the result of sample collections at the headworks for Deer Island and Deer and Nut Island Influent.

Non-conventional pollutant loadings (metals, acids and base neutrals organics, volatile organics, pesticides and PCBs) to Deer Island will increase in the future in proportion to the increase in future wastewater flow to the plant (approximately 15 percent) and the degree to which CSOs are captured. For selected non-conventional pollutants the CSO increase ranges from a few percent up to 25 percent compared to existing loadings, assuming that all CSOs are captured and returned to the plant.

3.0 TREATMENT PLANT

3.1 PLANT PERFORMANCE

The treatment plant performance and its effluent quality can be described in terms of the two general categories used to describe the treatment plant loading: conventional pollutants and non-conventional pollutants. BOD and TSS are the parameters commonly analyzed to determine plant performance. The required removal efficiency for conventional pollutants is defined by the National Pollutant Discharge Elimination System (NPDES) permit as that required to meet national standards for secondary treatment. Desired removal efficiencies for conventional parameters establish the sizing of primary and secondary facilities. Once a degree of primary and secondary treatment is established, removals of the non-conventional pollutants can be estimated. Levels of removal of the non-conventional pollutants are not significantly controllable in primary and secondary treatment units.

The discharge permit recognizes that there is inherent variability in the day-to-day loadings and operation of secondary treatment facilities. Thus, permit limits are specified in terms of concentration and time. The Authority's NPDES permit for secondary treatment has specified that the discharge must contain no more than 30 milligrams per liter (mg/l) BOD or TSS on a monthly average basis, not more than 45 mg/l of either pollutant on a weekly average basis, and not more than 50 mg/l of either pollutant on a daily basis.

The secondary portion of the Deer Island treatment plant has been sized to treat flows up to a rate of 1080 mgd. Flow in excess of this, up to the total plant capacity of 1270 mgd, would receive primary treatment and be mixed, after screening to remove floatables, with the secondary effluent for subsequent disinfection and discharge to the outfall. The BOD and TSS concentration of the mixed effluent will meet required secondary discharge limits. Average annual effluent from the proposed secondary treatment plant is expected to be 15 mg/l BOD and TSS.

The NPDES permit also requires a minimum of 85 percent removal of both BOD and TSS based on monthly average values. This requirement may not be met under all circumstances. During high groundwater conditions, when the incoming wastewater is diluted, the projected monthly percent removals are estimated to be about 77 to 79 percent. These lower removal rates are the result of the weak influent concentration and not the result of decreased process efficiency. To attain 85 percent removal under these conditions the secondary effluent would have to be consistently less than 15 mg/l BOD and TSS. Higher levels are not achievable without going beyond secondary treatment. The EPA's national policy allows for adjustment of the percent removal requirement provided that the effluent concentration limitations are met and that the dilution is not the result of excessive infiltration/inflow as defined by EPA rules and regulations. MWRA's existing infiltration/inflow policy and program are focused on the EPA rules and regulations related to the elimination of excessive flows.

Removal rates for the non-conventional pollutants were estimated based on typical removal rates for metals and volatile organics at other secondary treatment plants. The volatile organics are removed at rates of 90 percent or greater in secondary treatment facilities. Projected

removal efficiencies for fourteen metals detected in the MWRA raw wastewater vary from 5 percent for boron to 90 percent for silver. Typically, the efficiency of metals removal ranges from 50 to 75 percent, although the rate is quite variable for various metals.

3.2 EVALUATION OF ALTERNATIVE UNIT PROCESSES

Alternative unit processes for preliminary, primary, and secondary treatment, as well as effluent disinfection, were evaluated in a three-step process. The initial step consisted of a screening and preliminary evaluation of a wide range of alternatives. From this screening, a limited number of alternatives were retained for a detailed evaluation. Finally, recommended treatment facilities were selected, based on the detailed evaluation.

3.2.1 SCREENING AND PRELIMINARY EVALUATION OF ALTERNATIVES

Thirty-five unit processes were initially identified as potentially viable for either preliminary, primary, secondary, or disinfection treatment alternatives. The processes were selected after considering a wide range of conventional and state-of-the-art treatment alternatives. The processes identified were considered viable for initial preliminary evaluation and screening because of a demonstrated ability at large wastewater treatment plants to consistently meet treatment standards, and/or the flexibility to operate in various treatment modes under different hydraulic and loading conditions. Each unit process was evaluated on the basis of area requirements, operating history and performance at other large municipal wastewater treatment plants, relative capital and operating costs, and fourteen other screening criteria related to construction, operational, and environmental considerations. The thirty-five individual unit processes evaluated during the preliminary evaluation and screening phase and the fifteen unit processes carried forward for detailed evaluation are presented in Table 3-1.

3.2.2 DETAILED EVALUATION OF ALTERNATIVES

Treatment processes retained from the screening evaluation for both the Deer Island secondary treatment facility and the Nut Island headworks were compared in a detailed evaluation using technical, environmental, institutional, and cost considerations. Site planning goals and mitigation commitments also influenced the selection of the recommended plan.

Nut Island

Preliminary Treatment

To protect the inter-island conveyance system and the South System pumping station to be constructed on Deer Island, preliminary treatment, consisting of screening and grit removal for the South System flows, will be provided at the new Nut Island headworks. Two alternate screening methods, climber screens and catenary screens, were evaluated; and two alternate grit removal methods, centrifugal grit and aerated grit, were analyzed. Climber screens are recommended for screening of influent wastewater at the new headworks, based on MWRA operational familiarity as well as operational and maintenance advantages over the catenary

TABLE 3-1
SUMMARY OF SCREENING EVALUATION

<u>UNIT PROCESSES EVALUATED</u>	<u>UNIT PROCESSES RETAINED FOR DETAILED ANALYSIS</u>
<u>PRELIMINARY TREATMENT</u>	
Climber Bar Screens	Climber Bar Screens
Catenary Bar Screens	Catenary Bar Screens
Horizontal Flow Grit Channel	
Aerated Grit Chamber	Aerated Grit Chamber
Centrifugal Grit Chamber	Centrifugal Grit Chamber
Cyclone Primary Sludge Degritting	
Preaeration	
<u>PRIMARY TREATMENT</u>	
Rectangular Clarifiers	Rectangular Clarifiers
Circular Clarifiers	
Sedimentation with Chemical Addition	
Tray Clarifiers	
Stacked Clarifiers	Stacked Clarifiers
Inclined Tube Settlers	
<u>SECONDARY TREATMENT</u>	
Air Activated Sludge	Air Activated Sludge
Oxygen Activated Sludge	Oxygen Activated Sludge
Burns-McDonnell Treatment System	
Powdered Activated Carbon	
Deep Shaft Activated Sludge	
Sequencing Batch Reactor	
Rotating Biological Contactor	
Trickling Filter	
Biological Filtration	
Coupled System	Coupled System
Pulsed-Bed Filtration	
Physical-Chemical Treatment	
Rectangular Clarifiers	Rectangular Clarifiers
Circular Clarifiers	
High Rate Clarifiers Followed by Filtration or Microscreens	
Tray Clarifiers	
Stacked Clarifiers	Stacked Clarifiers
Screening (for primary effluent)	Screening (for primary effluent)
<u>DISINFECTION</u>	
Liquid Chlorine	
Sodium Hypochlorite	Sodium Hypochlorite (purchased on-site or off-site generation)
Ozone	Ozone (only with oxygen activated sludge.)
Ultraviolet Irradiation	Ultraviolet Irradiation

screen alternate. Centrifugal grit removal is recommended at Nut Island rather than aerated grit removal. Both types of grit removal are proven processes and the institutional impacts of each are nearly identical. However, the centrifugal grit removal alternative was selected because of lower capital and operating costs and reduced volume of air flow requiring air emissions control. Capital costs for the centrifugal system are 60 percent of the capital costs for the aerated grit removal system, and operating and maintenance costs for the centrifugal units are 80 percent of the O & M costs for the aerated grit units.

Deer Island

Main Pumping Station

The existing Main Pumping Station at Deer Island will require modifications in order to pump flow from the North Metropolitan Relief tunnel and the Boston Main Drainage Tunnel to the new treatment facilities. The major changes include replacement or modification of all ten pump units, including electric motor and variable speed drives and the addition of new knife gate valves on the suction of five pumps and on the discharge of all ten pumps.

Two 11.5-ft-diameter force mains will be constructed to convey wastewater from the North Main Pumping Station and Winthrop Terminal to the North System grit facilities.

Preliminary Treatment

The grit and screening removal equipment at the three existing North System remote headworks, currently being upgraded as part of the Fast-Track Improvements Program, will adequately protect the conveyance system and raw wastewater pumps throughout the planning period. However, as evidenced by grit buildup at the existing Deer Island plant, additional grit removal is required to protect the new treatment facilities. This additional grit removal for the North System flows will be provided by new grit facilities on Deer Island operating in series with the existing remote facilities. As with the Nut Island preliminary treatment facilities, centrifugal grit removal is also recommended for the new Deer Island grit removal facilities.

Primary Treatment

The factors of primary concern in the selection of the recommended plan for Deer Island were unit process area requirements and site layout, together with operational reliability and flexibility. During the detailed evaluation phase, a concurrent review of the alternative unit processes, the site constraints, and the site planning objectives immediately revealed that minimizing the area required for each unit process was imperative. The most feasible and accommodating process option available to meet this requirement was the use of stacked rectangular clarifiers for both primary and secondary sedimentation.

Preliminary site layouts of the treatment plant on Deer Island indicated that the use of conventional rectangular clarifiers was not a viable alternative for either the primary or secondary treatment systems. The use of conventional, rectangular units would require

commitment of the entire Deer Island site for process basins and would not allow space for separation berms, plant roadways, control buildings, and other ancillary facilities. Therefore, the use of stacked rectangular clarifiers was the only alternative considered for both primary and secondary treatment.

To date, stacked rectangular clarifiers have not been used in the United States. However, various configurations of the units have been used in both primary and secondary treatment applications in Japan for over a decade. Over 37 Japanese plants now use them, including 8 plants with an average flow over 100 mgd. The Japanese installations produce effluents equal to or better than the conventional rectangular clarifier units.

Secondary Treatment

The three alternatives evaluated for secondary treatment -- air activated sludge, oxygen activated sludge and the coupled system (packed tower followed by activated sludge) -- have similar capital, operating, and life cycle costs. Of the three alternatives, the coupled system has the greatest capital costs, operation costs, and power consumption.

The three alternatives can be considered equal regarding potential noise impacts on neighboring homes, constructibility, effluent quality, and residual quantity and quality. The air and oxygen activated sludge systems can be considered equal with regard to area requirements, while the coupled system is slightly more area-intensive.

Operationally, the coupled system is slightly more complex, since the process requires control of two biological systems. The coupled system offered no distinct advantage over the activated sludge alternatives, and since it also had the highest costs and power consumption, it was eliminated from further consideration during the detailed evaluation of alternatives.

Thus, the activated sludge process utilizing stacked, rectangular clarifiers was selected for the secondary treatment component of the Deer Island treatment facilities. Alternative methods of providing oxygen to support biological stabilization in the activated sludge process were evaluated. Oxygen can be provided by air, or it can be generated on-site in a cryogenic oxygen generation unit. Either air or oxygen activated sludge would produce the desired plant performance.

The secondary treatment plant at Deer Island will be subjected to highly variable flows and loads due to the nature of the MWRA collection system. The ability to successfully maintain effluent quality under these variable conditions was an important parameter in selecting between air and oxygen for the activated sludge process. Oxygen activated sludge systems have an inherently greater capability to handle large variations in hydraulic and organic loadings than do air activated sludge systems. Operating oxygen activated sludge systems handling large variations in organic loads, flows, and chloride concentrations have demonstrated operating resiliency and considerable ability to maintain effluent quality. Oxygen systems have a proven track record in successfully handling large variations in organic loadings and have a clear advantage over air systems in this regard.

Additionally, there is significantly less process equipment and fewer components associated with the oxygen activated sludge system than are needed for the air activated sludge system. Most importantly, the air activated sludge system would contain over 100,000 fine bubble diffusers to entrain air into the wastewater. The success of the air activated sludge process is critically dependent on monitoring and maintaining the efficiency of these fine bubble diffusers. Monitoring and maintenance would be highly problematic with the covered aeration basins required to comply with air quality regulations at the new Deer Island secondary treatment facilities. Any maintenance on the fine bubble air diffusers and associated piping would require operator entrance into the covered basins. In contrast, the oxygen system utilizes mechanical aerators that can be maintained from the top of the covered oxygen basins by lifting the aerators with a mobile crane. Oxygen system operators report that maintenance personnel are seldom, if ever, required to enter the covered oxygen basins. The MWRA Secondary Treatment Facilities Plan Operations Review Committee unanimously agreed that, with covered aeration basins, an oxygen activated sludge system would be preferred over air activated sludge.

All of the off-gases from the activated sludge process must be collected and treated to reduce odors, VOCs and other pollutants of public health concern. The collection and treatment of these gases is much more easily achieved in the oxygen activated sludge system than in the air system as the small quantities of off-gases from an oxygen system create an ideal situation for the application of emission treatment and control. Peak and average air flows for the air system are 280,000 scfm and 120,000 scfm, respectively. Corresponding values for the oxygen system are 6,000 and 3,000 scfm. Air emissions standards, particularly for air toxics, are in a state of flux. The oxygen activated sludge alternative, which generates only 2 percent of the vent air produced by air activated sludge, requires the least amount of control and offers significant advantages over the air system.

Given the level of equipment that must be maintained in each system, the operational complexity associated with the covered aeration basins in the air activated sludge system, the superior operational flexibility and reliability offered by the oxygen system, as well as air emissions requirements, the oxygen activated sludge system is preferred from an overall operability standpoint.

During the detailed evaluation phase, the use of an anaerobic selector basin, prior to the aeration basin, was also evaluated for both the air and oxygen activated sludge alternatives. For both alternates the anaerobic selector is expected to provide added stability and reliability under varying loading conditions and produces a better settling sludge, allowing for a decrease in secondary clarifier sizing.

Based on the above, oxygen activated sludge, using cryogenic generation of the oxygen, with stacked, rectangular secondary clarifiers, is the recommended secondary component of the Deer Island treatment facilities. This selection was based on the ability of oxygen to efficiently treat highly variable loads without process upset, as well as its overall operability and lower air emission control requirements. An anaerobic selector, employed prior to the oxygen aeration basins, is recommended as part of the secondary treatment components. The benefits associated with the selector, including increased stability under varying loading rates,

improved sludge settleability, and a potential reduction in overall oxygen requirements warrant its inclusion.

Disinfection

The alternatives evaluated for disinfecting the Deer Island effluent were sodium hypochlorite (purchased or generated on-site), ozone, and ultraviolet irradiation. Dechlorination with either sulfur dioxide or sodium bisulfite was included with the hypochlorite alternatives. Between the start-up of the primary facilities and the start-up of the secondary facilities, effective disinfection of primary effluent is required. Sodium hypochlorite is the only alternative which would provide adequate disinfection under these circumstances. Therefore, to implement ozone or ultraviolet (UV) irradiation as a disinfectant would require an interim sodium hypochlorite disinfection process between the start-up of primary and secondary facilities. Ozone is a questionable disinfectant for secondary effluents which exceed 30 mg/l TSS and BOD, such as those effluents that occur during maximum flow conditions at Deer Island. Ozone was eliminated from further consideration on the basis of this factor as well as its failure to offer any cost advantages.

Purchased sodium hypochlorite is preferred over ultraviolet irradiation even if subsequent water quality determination indicates that dechlorination procedures are required. The selection was primarily based on the present worth analysis which determined the present worth cost of the UV system to be 1.4 times the cost of the sodium hypochlorite system. A comparison of the sodium hypochlorite alternatives - purchased versus on-site generation - indicated that purchased sodium hypochlorite was a much more desirable alternative due to capital cost, operability, and power and staffing requirements.

The recommended plan for disinfection is to use purchased sodium hypochlorite. Since the results from the whole effluent toxicity tests indicated that dechlorination is necessary, sodium bisulfite will be used for this purpose.

Control of Air Emissions

This study investigated the emissions of odor-causing compounds and volatile organic compounds (VOCs) from the Deer Island treatment plant and the Nut Island headworks, and identified the impacts of these emissions on ambient air quality. The other headworks, which are currently undergoing renovation, are not included in this assessment. Their impacts will be reviewed after their renovation is complete, and sampling is conducted.

The emissions of odor-causing compounds and VOCs from the proposed treatment facilities are controlled under Federal, State, and local regulations. The control of odors was addressed as a required mitigation measure in the Secretary's Certificate on the Siting EIR. The mitigation standard requires that there be no detectable odor when one part ambient air is diluted in one part of odor-free air at the property line of the treatment plant. This standard requires the Authority to design the new treatment facilities to eliminate off-site odors.

The Commonwealth of Massachusetts has laws and regulations dealing with odors and VOCs. The laws for odors are set in general terms and seek to avoid nuisances. The laws and regulations for VOCs have specific numeric limits, however. These limits are set in regulations on two levels: 1) increase in emissions of VOCs; and 2) the ambient impact of individual compounds. The first concern sets limits on the total mass of VOCs emitted, and the second concern sets Allowable Ambient Levels (AALs) that should not be exceeded at all locations of public access beyond the fence line of the treatment facilities.

The source of emissions from wastewater treatment are interfaces between wastewater and air, and emissions increase where the surfaces are turbulent. At the facilities proposed for Deer Island, the sources would be tank surfaces (such as clarifiers), weirs, and aeration tanks. For tank surfaces, wind increases emissions of volatiles. For aeration tanks, biodegradation removes some of the volatile organics.

Emissions from several sources were calculated, and their effects on ambient air quality were assessed. The sources included in these calculations were:

- o Weirs after the grit removal facilities
- o Primary splitter box
- o Weirs after primary clarifiers
- o Secondary splitter box
- o Aeration basins and their weirs
- o Secondary clarifier surfaces and weirs
- o Surface of disinfection basins

Emissions from the grit removal facilities from the surface of the primary clarifiers were not estimated, because their amounts would be insignificant in comparison to the other emissions. These two surfaces will be quiescent and will be protected from the wind by covers. However, their emissions will be collected and treated, as will emissions from other minor sources such as vent shafts, Winthrop Terminal, the grit classifier building, aerated channels, and the screenings building.

All facilities up to the secondary clarifiers will be enclosed or covered. Their exhaust air will be collected and treated by wet scrubbing followed by activated carbon, at seven locations on the site. This treatment will decrease emissions of reduced sulfur by about 95 percent, and of VOCs by about 85 percent. The level of control proposed has been designed to meet the requirements for application of BACT (Best Available Control Technology).

Emissions of VOCs before and after control were estimated and compared to existing emissions at Deer Island and Nut Island. After control, the emissions from Deer Island and Nut Island will be less than existing emissions. This means that the air pollution control facilities will not have to meet rules for LAER (Lowest Achievable Emission Rate). LAER would have had to be met if the total emissions exceeded existing emissions by more than 40 tons per year.

Air-quality modeling consisting of screening, and detailed analyses were conducted. Projected impacts were compared to AALs. The comparison shows that the emissions after control will

produce ambient impacts that are less than AALs for all but one constituent. Those AALs will be exceeded infrequently, offshore north of Deer Island.

The recommended facilities will have insignificant impacts on the local populations in terms of ambient air quality. Recommended covers and emission control systems result in impacts on surrounding populations that are within allowable air quality limitations even under worst-case scenarios, except for one constituent. No odors associated with the liquid wastewater treatment facilities will be detected off-site.

Additional study is recommended to resolve some questions about emissions of odors and VOCs. The sampling program measured VOCs from the EPA priority-pollutant and hazardous-substance lists, and other VOCs identified from searches of peaks on mass chromatographs. However, other VOCs, in addition to those measured, could be emitted. These other VOCs include volatiles already in the wastewater and volatiles produced during wastewater treatment. Data are lacking on these two types of emissions, and studies need to be under taken to assess their importance.

3.3 RECOMMENDED PLAN

3.3.1 TREATMENT FACILITIES

There is a recommended base plan and there is also an alternate plan. This Section 3.3 summarizes the recommended base plan and Section 3.4 identifies the differences between the base plan and the alternate plan. The differences between the plans reflect alternate construction schedules for the secondary facilities. Under the alternate plan, the construction of secondary facilities is accelerated.

The recommended base plan for the MWRA treatment facilities consists of the following major components:

Preliminary Treatment

- o Screening and grit removal at existing North System remote headworks.
- o Screening at Winthrop Terminal.
- o Additional grit removal of North System flow at new grit facilities on Deer Island.
- o Screening and grit removal of South System flow at new Nut Island headworks.

Wastewater Pumping

- o Replacement and modification of existing pumps at the North Main Pumping Station and the Winthrop Terminal to allow discharge to the new treatment facilities.
- o Pumping of the South System flow at a new South System Pumping Station on Deer Island.

Primary and Secondary Treatment

- o Primary treatment to a flow rate of 1270 mgd in stacked rectangular clarifiers arranged in four batteries.

- o Secondary treatment using the oxygen activated sludge process consisting of four parallel batteries of sequentially arranged anaerobic selectors, aeration basins and stacked rectangular clarifiers. The maximum flow rate in secondary treatment is 1080 mgd.
- o Oxygen generation with two 300 ton per day cryogenic units with 1000 ton liquid oxygen storage capacity.
- o Fine screening of primary effluent in excess of 1080 mgd with traveling water screens.

Disinfection

- o Disinfection in chlorine contact basins with barge-delivered sodium hypochlorite followed by dechlorination with sodium bisulfite.

The sequence of treatment is presented schematically in Figure 3-1.

All of the treatment units except the secondary clarifiers and disinfection contact basins will be covered. Exhaust air from the covered treatment units, and from pumping station wet wells and wet shafts, will be collected and treated with wet scrubbers (using sodium hypochlorite and caustic soda) followed by carbon adsorption.

3.3.2 SITE LAYOUTS

Nut Island

The recommended layout for the new Nut Island headworks locates the facility at the site presently occupied by the existing anaerobic digesters. The site will be available once the MWRA's interim solids disposal program is in place by December 1991. Operation of the existing Nut Island treatment facility will be maintained throughout construction and start-up of the headworks facility. Decommissioning of the plant will commence once the headworks is operational.

The headworks facility consists of a headworks building and grit removal facilities. The most visible component of the facility will be the headworks building which houses the screening facilities, truck loading bays, air emissions control facilities, administrative, operation, employee and maintenance areas. This building covers approximately 19,000 ft² and is 20 ft high. The existing grade at the selected site is approximately 131 ft while the final grade at the site will be approximately 128 ft. The grit chambers are located below grade, adjacent to the headworks building, and cover an overall area of approximately 22,000 ft². The inter-island tunnel shaft is located adjacent to the grit chambers. Construction of the shaft will not interrupt the operation of the existing plant.

Access to the headworks facility is by either the existing main access road along the western side of the island, or the pier to be constructed at the northeast end of the island. The roadways on the island are arranged to provide safe traffic patterns for all vehicles, and allow fluid movement of the trucks serving the headworks facility.

The site plan for Nut Island allows for safe, shared use for wastewater treatment and passive recreation. Areas designated for wastewater treatment facilities are separated from the remainder of the island by fences and earth berms.

The portions of the site that have not been designated for wastewater treatment purposes are planned as open space for passive recreation. Landforms and vegetation on the island promote this use. This concept is consistent with the City of Quincy's land use zoning classification. A pedestrian path encircles the island, providing continuous views of Boston Harbor and Quincy and Hingham Bays, as well as convenient access to most of the island including the beach on the eastern shore.

Proposed landscaping on the island is functional, while at the same time creating a natural visual image. Earth berms up to elevation 140 ft are formed around and against the wall of the headworks building and grit chambers. The berms, trees and shrubs are arranged to visually screen the headworks facilities, primarily from Hough's Neck, but also from points across Quincy Bay and from the pedestrian path encircling the island. An architectural site plan of the developed Nut Island site is presented in Figure 3-2.

Deer Island

The Deer Island site plan consists of four interrelated parts - the buffering landforms, the treatment facilities, the support facilities, and the residuals management facilities. These parts are linked by an external access system consisting of roadways, piers, and service roads and an internal access system consisting of passageways, pipe galleries, and stairwells. Each of the parts has its own distinct visual image - the landforms are gently sloped earthen and vegetated hills, and the treatment facilities are large massings of concrete basins. These parts have been assembled so that the concrete treatment facilities occupy the central portion of the site, the brick faced support facilities occupy the adjacent area on the western, southern and eastern side of the treatment facilities, and the landforms occupy the outermost portion of the site and effectively conceal the treatment facilities and support facilities on the northern, eastern and western sides of the site. The appearance of the recommended facilities to a viewer will depend upon the viewer's location. Within the landform areas on the outer edge of the site, the visual image will generally be of the earthen vegetated hillsides. This image will also be seen by distant viewers, particularly those to the north and east of the site. The view from the external access roadway located between the western landforms and the treatment facilities will be of the brick faced support facilities backdropped by the concrete walls of the basins, with earth landforms rising around the horizon. From the treatment facilities, the view will consist of a large expanse of covered and uncovered basins surrounded by support buildings which are backdropped by the earthen landforms. The recommended site layout is shown in Figure 3-3.

Vertically, the design of the site is organized around two distinct zones. The lower/access zone is at an approximate elevation of 120 to 130 ft and is the level at which the piers, access roadways, internal passageways, and the ground floor of the support buildings are located. The upper/facilities zone at elevations 145 to 155 ft is the level at which the tops of basins, air emission control facilities, operation buildings, and service roadways are



PIER

HEADWORKS FACILITY

ACCESS ROAD

0 50 100 200

MASSACHUSETTS
WATER RESOURCES
AUTHORITY

FIGURE 3-2
NUT ISLAND SITE PLAN



located. Within the facilities, air emission exhaust stacks, potable water storage tank, oxygen plant distillation columns, and power plant exhaust stacks create vertical spikes rising to elevations between approximately 200 to 230 ft. Around the facilities the landforms rise to elevations ranging from approximately 180 to 220 ft and are connected by ridges with elevations of approximately 150 ft.

The main process area of the liquid treatment facilities is aligned in a rectangular grid on a generally south-to-north axis, extending from approximately the southern edge of the existing drumlin and proceeding northward to the area currently occupied by the Hill Prison structure. The southern portion of the main process area consists of primary treatment facilities, the central portion is dedicated to the anaerobic selector basins and the aeration basins, and the northern end consists of the secondary clarifiers. The plant is subdivided within each of the primary and secondary treatment areas into four equal sized batteries, with each of the batteries containing multiple basins. Residuals handling facilities (per the Residuals Management Facilities Plan) will be located in the area between the liquid treatment facilities and the southern tip of the island.

The support facilities have been located along the western, southern and eastern side of the plan as independent, brick faced structures with either connecting tunnels, passageways, or bridges to the main treatment structure. The majority of the support facilities including the power facilities, North Main Pumping Station, maintenance, warehousing, administration and laboratory operations have been located along the western side of the treatment facilities. On the southern side of the treatment facilities are located the primary facilities operations management center, the grit handling facilities, and the South System Pumping Station. On the eastern side of the treatment facilities are located the oxygen generation plant and the primary effluent screening structure.

Access to Deer Island will be both overwater and overland. Overwater traffic will unload and be controlled at the proposed new pier facilities. A vehicular access road along the western side of the treatment facility will connect the pier to the administration building, the treatment facility lower zone, maintenance facilities, and residual facilities. The vehicular access road will be ramped up to the northern end of the facilities, and on the western side at the maintenance buildings adjacent to the secondary clarifiers. The service roads completely surround and access the upper facilities zone.

An overland vehicular access road will connect Point Shirley to Deer Island. This road will have controlled access at two points. One of the control points will be a fenced gate at the property line, adjacent to Point Shirley and the northernmost outer berm. The second control point will be the entrance to the treatment facilities at the inner limit of the separation zone. This overland access roadway follows the western shoreline to the area of the administration building. This roadway alignment directs visitors from the overland access routes to the same common point, the administration building, as the overwater access routes. Within the separation zone, north and east of the plant, construction of a pedestrian footpath is contemplated. It would commence at the northern gate near the man-made drumlin and follow the northeastern shoreline of Deer Island to its southernmost tip. A control fence located at

the inland foot of the landforms will prevent pedestrians from entering the treatment plant areas.

Within the treatment facilities are numerous pipe galleries that have been configured to provide the plant with the internal circulation system for the lower/access zone through connected passageways between the various process elements. The main internal passageway runs from the pier area northward through the treatment facility. Main east-west passageways run at right angles to the north-south passageways in three locations: the east-west passageway between the primary clarifiers and aeration basins connects to the administration building and the primary effluent screening building; the east-west passageway between the aeration basins and the secondary clarifiers connects the vehicle maintenance building, secondary operations center, return activated sludge pump station, and plant water pump station; and the east-west passageway between the batteries of secondary clarifiers connects the maintenance and parts storage facilities to the internal access system. Minor passageways and pipe galleries would be located between process batteries as necessary for equipment access. Egress and ventilation shafts from the passageways are typically located at the ends and midpoints of the primary and secondary clarifiers batteries.

3.3.3 PLANT UTILITIES

Power

No public electrical utility currently services the Deer Island wastewater treatment facility. All electrical energy required at Deer Island at present is generated on-site by five, 700 kw diesel engine driven generators. Additional diesel engine-driven generators are being installed as part of the fast-track improvements to meet present day demands and should be operational by late 1989.

The estimated average electric power requirements for the various phases of construction and operation of the treatment facility are summarized below:

<u>Year</u>	<u>Average Load (kw)</u>
1990	14650
1991	18650
1995	24050
1999	36800

To meet these demands, a combination of on-site generation and off-site supply from Boston Edison Company (BECo) were evaluated using technical, economic, and environmental evaluation criteria.

The recommendation to provide sufficient, reliable power to Deer Island in all phases of construction and operation consists of the installation of a temporary power supply cable, followed by the installation of two 115 kv feeder cables and a combined cycle power plant. A summary of the recommended power plan is as follows:

- o Install a temporary power supply cable by 1990 or sooner. Based on preliminary information, approximately 15 to 20 MW of power will be provided by Massachusetts Electric Company (MECo) from its Metcalf Square Substation in Winthrop. Additional information describing the cable routing and construction impacts will be included in a supplement to Volume III.
- o Install a 115 kv permanent feeder from BECo's K Street substation in South Boston by January, 1991. Placing the feeder in service requires the installation of a 115 kv to 13.8 kv substation on Deer Island.
- o Install an on-island 25,700 kw combined cycle power plant by January, 1995 to provide additional capacity for peak shaving and also to provide protection against catastrophic failure of the off-site power sources. This additional capacity, combined with the soon-to-be-installed fast-track capacity, will result in an installed on-site capacity of 37,700 kw.
- o Install the second BECo 115 kv permanent feeder by January, 1995. This feeder will originate from BECo's Chelsea substation.

On-site sludge digestion and its associated costs and benefits are being studied as part of the Residuals Management Facilities Plan. On-site digestion would produce methane gas which can be used as a fuel in the on-site power generation facilities.

Heating Demand

The heating demand at the Deer Island treatment facilities will increase as new wastewater treatment facilities are constructed. The expected total yearly heat load, based on seasonal steam demand per degree days, has been estimated at approximately 86,000 million Btu.

Heat will be extracted as steam from the combined cycle power plant.

Potable Water and Plant Water System

Potable water needs for the new Deer Island wastewater treatment facilities were estimated and contrasted with existing water availability, and alternative approaches to support Deer Island's water supply needs were evaluated.

Potable water is presently used at the wastewater treatment facility for toilets, sinks, drinking fountains, sludge heaters, engine cooling, equipment flushing and washdown, and seal water. This water is supplied from the Winthrop water distribution system. Current average and maximum consumption rates are 0.1 mgd and 0.2 mgd, respectively. Water use will increase when the plant is upgraded to an average daily consumption of 1.0 mgd and a maximum daily consumption of 2.0 mgd.

Potable water required by the new Deer Island facilities cannot be supplied through Winthrop's existing distribution system due to the limitations in the system. A water supply study concluded that Deer Island potable water needs are best met by constructing a dedicated 20-in-diameter main through Winthrop to Deer Island.

The recommended plan provides for a 1.54 million gallon on-site storage of potable water at Deer Island in order to dampen the effects of diurnal flow-rate variations, to provide adequate pressure for firefighting, and to provide a source of water in the event of a break in the dedicated main.

In order to minimize the consumption of potable water, the recommended Deer Island facilities are designed to reuse primary and/or secondary effluent for those purposes which do not require potable quality water. Non-potable water is designated plant water, and will be used as necessary for engine cooling, process equipment flushing and equipment washdown. Plant water will be provided by a 45 mgd (31,250 gpm) plant water pumping station discharging directly to the plant water distribution system.

3.3.4 ENVIRONMENTAL CONSIDERATIONS

The environmental assessment of the treatment recommendations considers impacts on groundwater, air quality, land use and visual aspects, traffic, noise, terrestrial and aquatic ecology, and historical and archaeological resources on both Deer Island and Nut Island.

Groundwater

Groundwater levels on Deer Island generally vary between elevations 108 and 114 ft. Since most construction activities at Deer Island and Nut Island will be well above groundwater levels, and since no future use of groundwater is proposed at the new facilities, no impacts on this resource are expected.

A secure landfill will be located in the southernmost landform on Deer Island and will provide for the disposal of the grit and screenings presently buried south of the central drumlin. Demolition debris such as brick, wood, plaster and block removed from the existing military structures, will also be placed in the secure landfill. The landfill design will comply with the DWPC criteria for "sludge only" landfills and will use a double liner and leachate collection system to provide permanent protection for the groundwater resource. Plans for the disposal of such demolition debris as reinforced concrete, bricks, masonry, asphalt and other miscellaneous products will comply with the DEQE Division of Solid Waste criteria.

Air Quality

The applicable air quality standards for the Commonwealth of Massachusetts are the same as the National Ambient Air Quality Standards (NAAQS).

The air quality impacts of the power and pump stations on Deer Island indicate that the 1995 power generating configuration would improve air quality in the area for all pollutants compared to existing emissions.

The proposed treatment system incorporates covering the treatment process units through the aeration basins, and operation of air emission controls such that even under a worst-case scenario, the impacts will be within allowable air quality limitations at all locations which are accessible to the public. At the more easily accessible locations (neighborhood sites adjacent to the facility), the impacts have been determined to be insignificant.

Land Use and Visual Impacts

Deer Island

Construction and operation of the new wastewater treatment facility on Deer Island will change land use on those portions of the island currently used for activities other than wastewater treatment. Upon completion of the construction activities at the turn of the century, virtually the whole island will be dedicated to wastewater treatment. Existing facilities will have been demolished (with the exception of historic structures identified for preservation and reuse), and earth movement will significantly change the profile of the island. Earthen berms will serve to separate the treatment plant and the Town of Winthrop. A large area of open space on the neck of the island and a footpath located along the eastern edge of the island will be open for public access.

Upon completion of the facility and landscaping, the island will appear more natural from most viewing locations than it does at present.

Nut Island

The construction of the new headworks on Nut Island should significantly improve the compatibility of land use with abutting neighborhoods as well as provide a new area for passive recreational opportunities. The appearance of the site will be more natural, with landscaping and vegetation replacing the current concrete and asphalt surfaces.

Traffic

Due to the implementation of significant mitigation measures, transportation impacts in the town of Winthrop resulting from the construction of the Deer Island Treatment Facilities will be minimal. Although large numbers of workers and quantities of construction materials will be required, a minimum of one-half of the workers will be transported by ferry and the remainder will be transported by buses, from satellite parking facilities. With the exception of contingency trucking, all materials and equipment will be transported to Deer Island by barge.

Transportation impacts at Nut Island are being addressed in the on-island Water Transportation Facilities Planning FEIR.

Noise

Deer Island

Operation Noise. The new wastewater treatment facility on Deer Island will include equipment such as pumps, compressors, motor drives, a gas turbine, and an oxygen generation system, which have the potential to create audible off-site noise. An analysis was performed to identify the significant potential contributors to off-site noise, to estimate their sound levels in Point Shirley, and to select the appropriate noise mitigation required to minimize operations noise impacts.

To evaluate noise impacts from the facility, ambient noise levels were measured to serve as evaluation criteria. The levels found were 39 dBA nighttime and 45 dBA daytime. The noise evaluations have indicated that no noticeable increases above these evaluation criteria will be experienced during facility operation.

A considerable amount of the equipment will require noise attenuation. However, with the implementation of noise mitigation, the total sound level contribution of the facility at the nearest neighbor during nighttime hours is expected to be approximately 36 dBA, 3 dBA lower than the minimum ambient sound levels measured in 1986. Under the most favorable noise propagating conditions, a less than 2 dBA increase in existing ambient sound levels will occur. This change in ambient sound levels will not be noticeable.

Construction Noise. The construction of the facility will continue over a period of approximately twelve years, 1988 to 1999. During that time numerous buildings, treatment facilities and earthen landforms will be constructed, and the existing plant and prison will be demolished. The greatest potential for noise impact at Point Shirley will occur during the early stages of construction with the movement and placement of the earthen landform at the northern end of Deer Island. Once constructed, this landform will serve to buffer the remainder of the construction noise.

The criteria of 39 dBA, nighttime, and 45 dBA, daytime, were also used to evaluate noise impacts from facility construction. Various mitigation strategies were employed to implement a noise control objective which would limit intrusive daytime construction noise to no more than 10 dBA over those ambient levels.

The most significant noise mitigating measure which will be utilized during construction is the placement of new landforms. The northern landform has been determined to be an effective noise barrier during construction, reducing noise perceived at Point Shirley by about 10 dBA for eighty-three percent of the daytime. Maximum construction noise at Point Shirley will be approximately 50 to 54 dBA during upwind and cross-wind conditions, when the noise barrier is most effective. Approximately 17 percent of the time, down-wind conditions limit the effectiveness of the noise barrier. Noise levels range between the low 50s to a maximum of 65 dBA under these worst-case conditions. Analysis of ambient noise monitoring data from Point Shirley has indicated that these projected, worst case impact noise levels are characteristic

of the area and occur during 97 percent of the daytime for about six minutes each hour. The projected construction noise levels are similar in magnitude to the existing daytime median or L_{50} levels, which range from 47 dBA to 63 dBA.

Nut Island

Operation Noise. The new grit and screening facility at Nut Island will be completely enclosed, with expected sound levels of less than 25 dBA at the nearest residential area. Since the daytime and nighttime minimum ambient sound levels have been reported at about 50 dBA and estimated at 30 to 35 dBA, respectively, operation noise at the screenings facility will not be audible at the nearest residential area.

Construction Noise. The primary construction activities on Nut Island consist of the demolition of the existing facility, site preparation, and construction of the new building. The construction sound level is expected to be 63 dBA from 1992 to mid-1995, dropping to 60 dBA for the remaining year of construction.

Terrestrial and Aquatic Ecology

Sources of potential impacts on fauna and flora associated with the construction effort include: habitat removal and the subsequent displacement of fauna from cleared areas; the generation of fugitive dust; increased potential for erosion of cleared surfaces; construction generated noise; and the movement of construction personnel, equipment and materials on-site.

Land clearing is expected to have an adverse impact on the habitat of local wildlife species. However, none of the faunal species are endangered, threatened, or otherwise unique. The post-construction repopulation of the species on Deer Island is expected; thus the loss of these individuals does not constitute an impact of consequence.

The existing flora, primarily grass, is fairly resistant to impacts from fugitive dust. Dust control will be implemented through the use of water spray trucks to dampen exposed surfaces. No impact of dust on vegetation in adjacent communities is expected.

Erosion will be controlled through temporary stabilization of graded areas with seeding, tacking or mulching until permanent cover is established. The construction mitigation program will ensure that runoff from exposed surfaces will drain to settling basins, holding ponds, hay bale barriers and/or silt fences prior to discharge to the harbor.

Since the areas surrounding the construction zones presently do not support an appreciable number of wildlife species, no long-term deleterious impact from construction-related noise and movement of personnel, equipment and supplies is anticipated.

Few if any negative impacts on the terrestrial and aquatic ecology are anticipated from the construction and operation of the headworks on Nut Island.

Historical and Archaeological Resources

No historical or archaeological resources have been identified on Nut Island.

Historical and archaeological resources on Deer Island consist of the following:

- o Hill Prison
- o Superintendent's House
- o Steam Pumping Station
- o Farmhouse
- o New Resthaven Cemetery

Consideration was given to potential preservation and reuse of these resources, compatible with the treatment facility site planning needs; impacts of site development on these resources; and proposed measures which would mitigate impacts on these resources.

The land requirements for the new secondary treatment facility use virtually all of the land on Deer Island and thus reduce the flexibility for planning reuse of historic structures.

Site planning evaluations have recommended that the Hill Prison and the Farmhouse be documented for the Historic American Building Survey and subsequently demolished. The Superintendent's House will be moved to a higher elevation and reused as a security center for the new treatment plant. The Steam Pumping Station, situated near the water where the proposed piers will be constructed, will be renovated and expanded for use as the administrative and laboratory functions. The new Resthaven Cemetery will be left intact: the addition of 30 to 40 ft of fill material to the surface of the cemetery will provide a mitigating noise and visual barrier, and will act as an appropriate preservation for the Cemetery.

In accordance with Section 106 procedures, a Memorandum of Agreement (MOA) between the Massachusetts Historical Commission, EPS, and MWRA is being drafted. When executed, the MOA will establish the final disposition of historical and archaeological resources and identify agreed-upon mitigative commitments.

3.4 ALTERNATE PLAN

The milestone dates entered by the federal court for the construction of the new treatment facilities on Deer Island were premised on a sequential construction of the new primary and secondary treatment facilities, with the primary facilities completed in 1995 and the secondary facilities completed in 1999. However, the Court requested that MWRA review the sequence of construction following the completion of facilities planning with a goal of expediting construction of all or part of the secondary facilities.

Expediting construction of the secondary facilities is accomplished by an alternate plan which provides the distinct benefit of an accelerated construction schedule and an improved effluent quality during the years 1996 to 1999 in comparison to the base plan. The alternate plan will

discharge a mixture of primary and secondary effluent during the period from 1996 to 1999 as compared to the base plan which would discharge a primary effluent. The alternate plan is able to achieve this improved effluent quality, (and by extension an improved receiving water quality) without creating adverse impacts in other elements of the facilities plan. The construction schedule is altered to shift resources to the construction of secondary facilities at an earlier date. A modest increase in capital costs for the alternate plan (less than one percent) actually results in a projected one percent decrease in bonded cost as a consequence of an accelerated cash flow during the early years of the project. There is no net impact on the projected user rates as a result of the alternate plan.

The alternate plan would require construction of all the primary treatment facilities, 50 percent of the aeration basins, and 25 percent of the secondary clarifiers, and associated works to provide secondary treatment for approximately 26 percent of the average high groundwater flow in 1996. By 1996 all wastewater would receive primary treatment from the new facilities. During 1995 the completed portion of the new primaries would have capacity to provide treatment for 50-60 percent of the design flow with the remainder treated at the existing facilities. The North System flow would be treated in the new facilities beginning in 1994, and treatment of South System flows would begin in 1996 at the new facilities.

For the alternate plan virtually all of the plant elements identified for the base plan (primary clarifiers, aeration basins, etc.) will remain exactly the same. The only plant element that changes under the alternate plan is the size of the cryogenic facilities and the associated blower building.

Under the base plan it was recommended that two 300 ton per day oxygen production facilities (including blower buildings, etc.) be constructed. These facilities provided the required capacity and redundancy at the lowest capital cost. For the alternate plan, however, construction of a 300 ton per day cryogenic plant for operation of 25 percent of the secondary plant would be inefficient since the oxygen demand ranges from 50 to 100 tons per day. For the alternate plan it is recommended that a total of three 150 ton per day cryogenic facilities be constructed. Initially one unit at 150 tons per day would be constructed. The lower turn-down limit of this unit of 75 tons per day would provide sufficient oxygen to operate two batteries of oxygen aeration basins. The remaining two units would be constructed as part of the completion of the secondary facilities.

The alternate plan will provide secondary treatment for 168 million gallons per day of the total plant flow for the period from 1996 to 1999. Providing limited secondary treatment at this stage produces an effluent with approximately 37 percent less BOD and 32 percent less TSS under average annual conditions as compared to primary treatment alone. The effluent quality would be somewhat better in 1996 for the alternate plan than for the base plan. This difference, however, would not alter the relative difference in the outfall sites under consideration.

4.0 INTER-ISLAND CONVEYANCE SYSTEM

4.1 INTRODUCTION

The consolidation of treatment of the North and South System flows at the new Deer Island Secondary Treatment Facility will require an inter-island conveyance system to transport a maximum of 360 mgd of South System flow from Nut Island to Deer Island, a distance of approximately five miles. Various construction methods, as well as the possible combination of construction methods, were investigated. The alternatives were evaluated and the recommended plan was selected based on technical adequacy, cost considerations, environmental impact, and institutional considerations.

4.2 DESCRIPTION OF ALTERNATIVES

The inter-island conveyance system could be constructed by any of three methods: marine pipeline, sunken tube, or deep rock tunnel.

A marine pipeline would be built by conventional marine construction methods. In deep water, barge-mounted equipment would be used to trench, lower and install sections of pipe in lengths of approximately 16 ft. and place backfill and stone cover protection as required. In shallow near-shore areas (surf zone), a stationary trestle supporting a traveling crane on rails would be constructed to perform the same duties as the barges.

The sunken tube method of construction has been successfully used on a number of underwater vehicular tunnels, particularly in the Chesapeake Bay area. This type of construction is considered potentially cost-effective for diameters over 12 ft, which is only slightly larger than that anticipated for the inter-island conduit. The tube would be fabricated from steel in lengths of approximately 200 ft. The tube would be outfitted with interior and exterior concrete, towed into position over an excavated trench, and sunk into the trench. Trench excavation, stone bedding, backfill, and cover protection would be similar to that performed for pipeline construction.

The deep rock tunnel alternative is also a conventional method of construction that has been used successfully in the Boston area and throughout the world. Vertical access shafts would be constructed on land at the beginning and at the end of the tunnel. These shafts would penetrate through the overburden and into sound rock, terminating approximately 200 to 300 ft below the surface. The tunnel would be excavated by a tunnel boring machine (TBM) or by drill and blast techniques, and lined with concrete.

4.3 EVALUATION OF ALTERNATIVES

The initial screening of alternatives revealed that there are limitations on the use of both the marine pipeline alternative and the sunken tube alternative for the inter-island conveyance system. The most important limitation is caused by the fact that the conduit must cross the main Boston shipping channel along the route from Nut Island to Deer Island. The crossing will

be in President Roads. A large-diameter pipe or sunken tube extending across the shipping channel is not practical for three reasons.

First, the water depths in the channel are 60 ft to 70 ft below mean low water. Due to burial and cover requirements to protect the pipe against potential damage from anchor dragging and scour from wave and tidal forces, the bottom of a pipeline trench would be approximately 80 ft to 90 ft below mean low water. Since the pipeline must slope continuously downward toward its terminus on Deer Island to prevent solids deposition, a pipeline trench across Deer Island would be well over 100 ft deep. This would place the lower 15 ft to 25 ft of the excavation into rock. The length of the trench would be over 2,000 ft. long. The depth of cut, length of trench, and required rock excavation make these alternatives undesirable.

Secondly, since all ship traffic to and from Boston passes through President Roads, major pipeline construction across this busy but narrow shipping lane would require careful coordination with the U.S. Coast Guard to avoid unsafe conditions during construction. Although this type of construction is possible, it is not desirable if alternative means are available.

Finally, although there are currently no plans to do so, it is conceivable that the shipping channel may be deepened during the project life or beyond. If this occurs, another conduit would have to be constructed.

For these reasons, the deep rock tunnel is the only method of construction considered feasible for crossing the Boston shipping channel. It would be possible, however, to construct a pipeline or sunken tube between Nut Island and Long Island with a deep rock tunnel from Long Island to Deer Island.

Based on this, the following three inter-island conduit alternatives were selected for detailed evaluation:

- o Alternative 1 - A single deep rock, concrete-lined tunnel with vertical access shafts located on Nut Island and Deer Island.
- o Alternative 2 - A single concrete marine pipeline from Nut Island to Long Island, and a single deep rock, concrete-lined tunnel from Long Island to Deer Island, with vertical access shafts on both Long Island and Deer Island.
- o Alternative 3 - A single concrete-lined sunken tube from Nut Island to Long Island and a single deep rock, concrete-lined tunnel from Long Island to Deer Island, with vertical access shafts on Long Island and Deer Island.

As in the case of the treatment plant, the alternatives were evaluated based on environmental, technical, cost and institutional criteria. For every criterion considered in the evaluation.

the deep rock tunnel is better than or equal to the other alternatives. The major advantages of the tunnel are that this alternative has the least environmental impact and the least cost. Tunnel construction results in only 200,000 yd³ of mostly rock spoil, which could be used as fill on Deer Island. Construction of either of the other alternatives would generate 1.6 million yd³ of mostly unusable dredged spoils. The tunnel has virtually no impact on fish, shellfish, and other marine biota, whereas the other two alternatives would temporarily disrupt approximately 46 acres of benthic habitat due to the required dredging. Because of this dredging, a complex and lengthy permitting procedure could be expected. The estimated project cost of the tunnel is about 56 percent of the cost pipeline/tunnel alternate and 37 percent of the estimated cost of the tube/tunnel alternate.

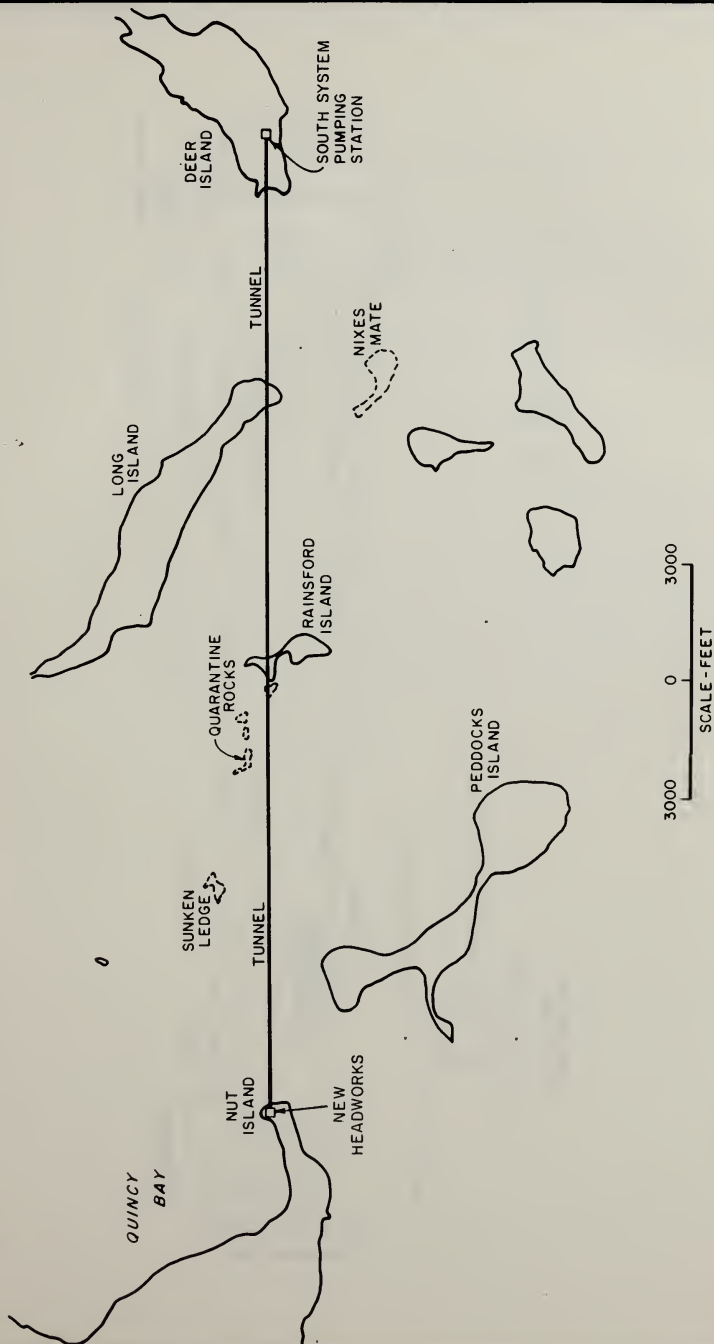
As noted earlier, a new South System pumping station, capable of pumping flows ranging from 80 mgd to 360 mgd, is also required. Although it was found to be technically feasible to locate the pumping station on either Nut Island or Deer Island, the Deer Island location was selected because the necessary pumping station support facilities will be constructed on Deer Island as part of the new wastewater treatment plant support facilities. The principal support facilities include redundant sources of electrical power, spare parts storage, and maintenance facilities. If the pumping stations were located at Nut Island, separate support facilities would have to be constructed, operated, and maintained.

4.4 RECOMMENDED PLAN

Based on the above evaluation, it is recommended that a deep rock, concrete-lined (either pre-cast concrete sections or cast-in-place concrete) tunnel connecting Nut Island and Deer Island be constructed with the South System Pumping Station located at Deer Island. The recommended inter-island conveyance system is shown in Figures 4-1 and 4-2. The tunnel, with a finished inside diameter of 11 ft, will be constructed in competent rock approximately 200 ft to 300 ft below sea level. The deep rock tunnel will be connected through vertical shafts at the new headworks at Nut Island and at the new South System Pumping Station on Deer Island. One vertical shaft will be located at each island. All wastewater passageways will be lined with concrete. The tunnel will follow a straight line from Nut Island to Deer Island, a distance of approximately 24,800 ft.

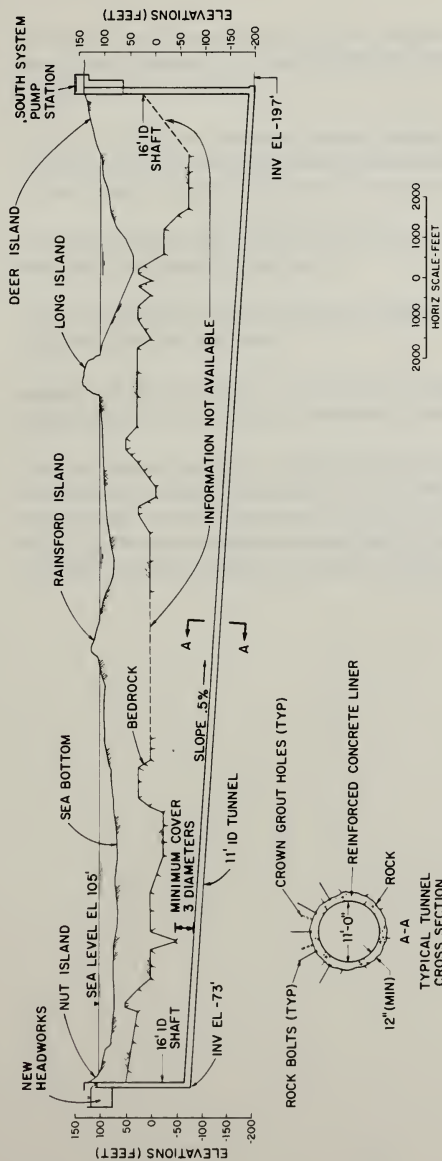
The recommended South System Pumping Station to be built on the southern side of Deer Island will include six pumps, each rated at 90 mgd. All pumps will be driven by an electric motor through a variable-speed eddy-current coupling drive. As indicated, the Deer Island location was selected because the necessary pumping station support facilities, such as redundant major sources of electric power, will be available on Deer Island. Eddy-current couplings were selected over variable-frequency drives because of their lower cost.

The environmental impact assessment of the recommended plan has identified the incremental effects on land and marine resources attributed directly to construction of the inter-island transport system during the 1991 through 1995 period. Overall, the recommended plan for the



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FIGURE 4-1
TUNNEL PLAN



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FIGURE 4-2
TUNNEL SECTION

inter-island conveyance system will have only the following minor effects on land and marine resources:

- o Continuous off-site construction noise levels predicted for the nearest residents at Point Shirley (Winthrop) and Great Hill (Hough's Neck) are approximately 10 dBA above existing ambient daytime noise.
- o There are essentially no impacts on marine resources because no marine construction is required for the recommended tunnel alternative and all tunnel spoils will be used on Deer Island to construct landforms for visual and noise barriers.
- o The pumping stations and vertical access shafts are not located in proximity to any historical or archaeological resources.
- o There are no effects on current or future potential for recreational opportunities on either Deer Island or Nut Island.
- o Impacts on terrestrial ecology will be minimal, considering the lack of any unique existing resources and the ongoing construction activities in the affected areas.
- o There are minimal impacts on traffic since MWRA has committed to ferrying one-half of the construction workforce and busing the remaining half from satellite parking areas. Except for a total contingency trucking volume of eight two-axle trucks per day, all construction equipment and materials will be transported to Deer Island and Nut Island over water from the on-shore pier facilities.

5.0 EFFLUENT OUTFALL

5.1 INTRODUCTION

Over the past two years studies have been conducted to determine the optimal location for the effluent discharge from the new Deer Island plant. These studies included investigations of the potential impacts of the construction and operation of the outfall, as well as investigations of alternative methods of constructing these facilities.

In addition, a continuing dialogue has occurred among MWRA, the regulatory agencies, and various citizens' groups to define relevant criteria that can be used to select an appropriate, acceptable outfall terminus. Twenty-four different criteria were selected, and were categorized into four broad areas: Environmental, Technical, Cost, and Institutional. These criteria form the framework for the analyses that led to the recommended location.

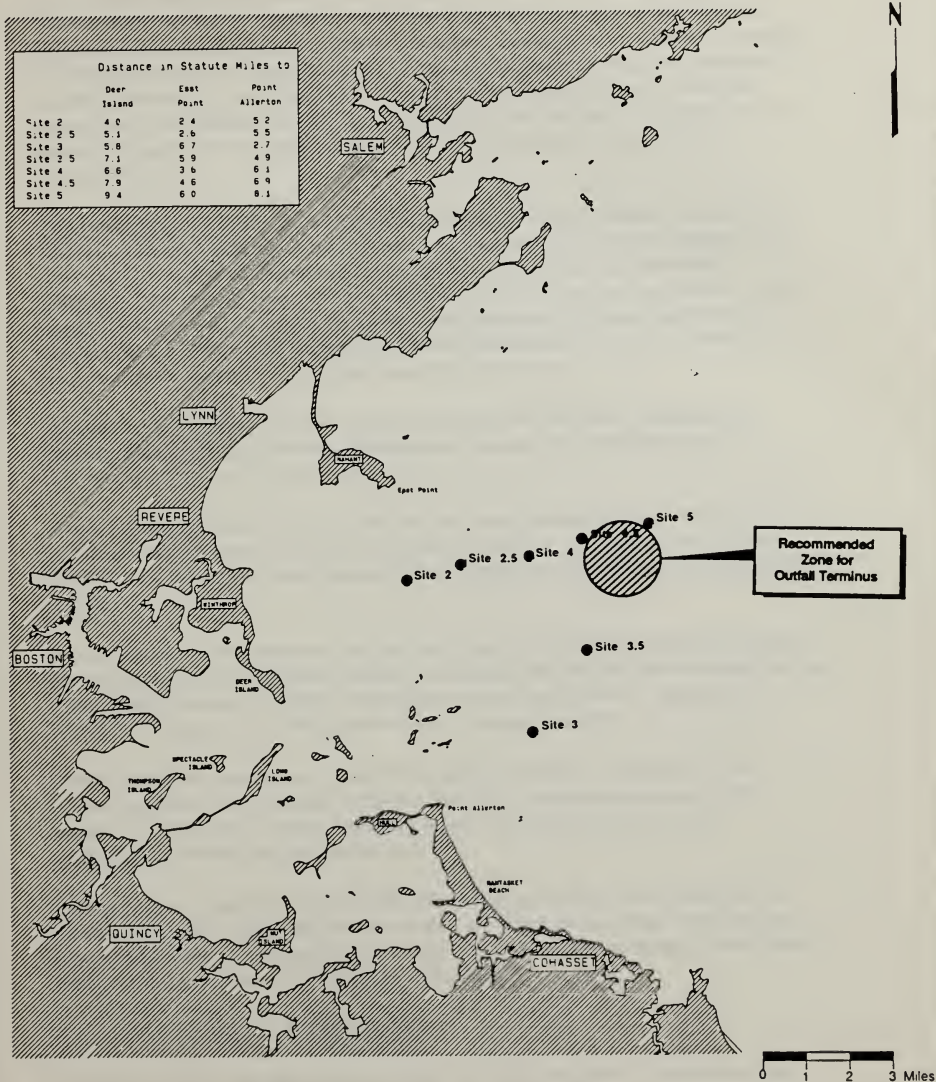
5.2 DESCRIPTION OF ALTERNATIVES

As was the case with the inter-island conveyance system, there is little evidence to suggest that dredged pipeline construction is either economically or environmentally feasible. Preliminary analysis also suggests that a mixed technology, tunneling and dredged pipe, would be considerably more costly and environmentally disruptive than tunneling alone. Accordingly, all alternatives discussed in this document are based on the construction of a tunnel to the discharge point. The tunnel will be constructed from a single vertical shaft located on Deer Island. The length of tunnel required to reach the most distant site is at or near the feasible limit of construction from a single heading. Figure 5-1 shows the location of the candidate site, the distance of each site from the shoreline, and the depth of water at each of the locations.

The candidate sites can best be understood by first describing the circulation, sediment depositional patterns and resource distribution within the area. Understanding these patterns provides a better basis for understanding the evaluation of environmental criteria.

The difference in circulation among candidate sites varies markedly. Two zones of circulation exist; a nearshore zone comprising Sites 2.0, 2.5, and 4.0 on the north and Site 3.0 on the south, and on off-shore zone, comprising Sites 4.5 and 5.0 on the north, and Site 3.5 on the south. Circulation patterns in the nearshore zone are most strongly influenced by tidal action, while those in the offshore zone are influenced not only by tidal action, but by the large-scale circulation of Massachusetts Bay itself.

This difference among zones has a large impact on outfall site selection. First, the direction of net circulation varies. At the nearshore sites, net circulation has a dominant east-west, or on- and off-shore trend. In contrast, the offshore locations have a strong north-south trend, along the coast. Second, the average dispersive capacity of the outermost sites is three to four times greater than the dispersive capacity of the innermost sites.



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FIGURE 5-1
RECOMMENDED OUTFALL LOCATION



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The sediment depositional patterns of the study area also vary. Two broad types of bottom characteristics are found: transition, where there is no net accumulation of sediment, and depositional where there are accumulations of sediment. However, for purposes of this study, ultimate depositional or erosional areas are of greatest importance for long-term placement of an effluent discharge. The distinction is important because many pollutants concentrate themselves in the sediment, and this can be magnified in the food chain. The difference in depositional patterns also provides an indicator of the relative vigor of the mixing of adjacent waters.

The areas adjacent to Sites 3.5 and 5.0 are best described as nondepositional (transitional), where the bottom is composed mostly of rock or cobbles with little overlying sediment. All other sites are considered depositional, in that there are broad areas of accumulated sediments. Within these areas there are apparent trends in the sediment geochemistry, which suggest that areas around Site 2.5 are concentrating pollutants to a higher degree than adjacent regions. This would suggest that this area may serve as a long-term reservoir of sediments, and that pollutants would be concentrated in this zone.

Modeling of the sediment deposition patterns also shows the same effect. Differences in sediment rates lead to the conclusion that nearshore sites accumulate sediments at approximately five times the rate of offshore sites.

Several marine resources now exist in the study region and adjacent areas. These include recreational uses of marine waters such as boating and fishing, commercial uses such as lobstering and fishing, and other resources which support these recreational and commercial activities.

Recreational uses of the regions around the study area are concentrated in closer proximity to the nearshore sites. Major regional beaches exist in Hull, Revere, and on the Nahant Bay side of the Nahant peninsula. Smaller, local beaches dot the entire coastline. Recreational boating and fishing are also concentrated closer to the nearshore sites.

Active commercial fisheries are distributed throughout the region. Lobstering is more extensively practiced at sites inward of Sites 4.0 and 3.5, while trawling occurs at most locations except Site 3.5. Fisheries statistics suggest that nearshore sites are more productive and diverse than are offshore sites.

The distribution of marine resources closely follows the commercial use of the region. In addition, areas within three miles of the shoreline are closed to commercial fishing during certain times of the year because of the presence of winter flounder spawning grounds and an attempt to distribute fishing activities more uniformly.

5.3 EVALUATION OF ALTERNATIVES

As with other major components of the project, four broad categories of criteria have been established for evaluating the alternatives. These include environmental, technical, cost, and institutional criteria.

5.3.1 ENVIRONMENTAL CRITERIA

In developing an overall evaluation of the environmental suitability of different sites as locations of the outfall, Sites 4.5 and 5.0 have been identified as preferred sites. The rationale for this conclusion follows:

- o The offshore sites offer the greatest potential for meeting numerical water quality criteria and standards. It is important to note that at all locations, source control of certain compounds to meet water quality criteria will be required. However, the outer sites, because they provide more robust mixing, provide the greatest opportunity to meet these criteria.
- o The offshore sites minimize problems associated with sediment accumulation and concentrating of pollutants. While there are no criteria currently available to define the importance of any specific level of contaminants in the sediments, the differences in deposition and chemistry demonstrate that offshore sites are better (e.g., less contaminated).
- o The offshore sites present the least opportunity for adverse impact on shoreline resources and aesthetics. The potential for creating nuisance algal blooms, which can be both an aesthetic and an environmental concern, is significantly less at the offshore sites because of their distance from other sources of contaminants and because of the more robust mixing that occurs. Moreover, the discharge will be trapped low in the water column and more frequently at the farther sites. This serves to minimize algal blooms and prevent excursions of the effluent onto the shoreline.
- o Sites further from shore are least likely to impact commercial uses of the marine resources. While resources exist throughout the region, their greatest abundance is located nearer the shore. Most notably, lobstering is conducted more extensively at Sites 2.0, 2.5, 3.0, and 3.5, and less so at 4.0, 4.5, and 5.0. Finfishing is less productive at Sites 3.5, 4.5, and 5.0. Areas within three miles of the coast are closed to fishing during certain times of the year because of their importance as spawning grounds, indicating again the sensitivity of these nearshore sites.
- o Because off-shore sites would result in fewer impacts as measured by long-term mixing, sedimentation and avoidance of important resource areas, they are judged to provide the greatest protection of local species from adverse stress.
- o Finally, the outer sites offer the least potential for impacts on historical shipwrecks.

In most other respects, the sites are equal. It is generally possible to meet the coliform criteria at all locations, and all alternatives have similar impacts with regard to noise and traffic.

5.3.2 TECHNICAL CRITERIA

All alternatives are essentially the same when compared by most technical criteria. All sites are judged to be equal in terms of reliability, operational complexity, and power needs because they are all gravity flow designs. This would translate to high reliability, low operational complexity, and minimal power needs.

In all cases, the construction of the alternatives is considered to be aggravated because of the nature of the expected method of construction. Sites further from shore are slightly more complex because of the difficulty of constructing such a long bore from a single heading, and because of the greater volume of tunnel spoils associated with the longer tunnel. Work underway suggests, however, that the greater volume of spoils may not be as negative a factor as previously thought - as it may be possible to use the spoils either as aggregate for low strength concrete, or as part of the Third Harbor Tunnel backfill requirements.

For the final technical criterion, flexibility, the offshore sites are assessed to be better. This criterion measures the capacity of any alternative to accommodate future changes - such as modified water quality requirements. As was noted in the environmental review section, the more offshore sites have a greater capacity to accommodate such changes.

5.3.3 COST CRITERIA

The cost criteria represent the financial investments which must be made for each of the alternatives. For most of the projects in the Deer Island STFP, cost criteria include considerations of both capital and operating costs. The outfall alternatives under investigation have essentially no operating costs because all designs are for a gravity-flow system. Accordingly, the most appropriate comparison is on the basis of project costs. The following table shows the differences in estimated construction costs:

<u>Estimated</u>	<u>Construction</u>	<u>Costs</u> (\$ Millions)
<u>Site</u>		<u>Cost*</u>
2.0		\$276
2.5		312
3.0		333
3.5		387
4.0		389
4.5		388
5.0		468

*Based on an Engineering News Record Construction Cost Index of 4440 for September, 1987.

It should be noted that the above costs include between \$120 and \$150 million for construction of the diffuser, with the remainder of the costs associated with the tunnel itself. Thus, alternatives which would involve constructing an outfall to one location, with the idea that it may be moved later, could incur a financial penalty of at least \$120 million related to this later relocation.

5.3.4 INSTITUTIONAL CRITERIA

The institutional criteria measure the differences between sites by ease of implementation (coordination requirements, permitting), and scheduling impacts, as well as the demand for unique construction resources. All sites are considered the same when measured by these tests.

The differences in estimated construction time are small-ranging from 47 months at the inner sites to 56 months at the furthest site. Moreover, the permitting requirements and construction resources are the same, regardless of the site. And finally, the outfall project cannot be built in sequentially-phased operating elements. Accordingly, all alternatives were not considered to be amenable to phasing.

5.4 RECOMMENDED PLAN

The proposed effluent outfall should be located in the region bounded by Sites 4.5 and 5.0 as shown in Figure 5-1. A comparison of Sites 4.5 and 5.0 indicates that Site 5.0 offers some additional environmental benefit, but cost considerations favor Site 4.5. The early design phase of the outfall should be focused on collecting detailed topographical and geotechnical information on the bottom in this region to facilitate the selection of the construction site. Additional monitoring will also be used to determine if there are any environmental factors which might indicate a clearer preference for the location of the diffuser within the region recommended.

These two sites represent the optimum mix of characteristics of good outfall sites: they are within the large-circulation patterns of Massachusetts Bay, and therefore provide the most robust long-term mixing. They are in regions of lesser potential sediment accumulation, thereby avoiding problems associated with concentrating pollutants in bottom sediments. They are located at a greater distance from extensively utilized nearshore resources, thereby avoiding the potential for disruption. Both sites can be reached by gravity and will support construction in a timeframe consistent with the court-ordered target dates.

The other shoreward sites do not represent viable options for the long-term discharge of effluent from the Deer Island facility. Outfalls placed in these locations are marginally acceptable when measured by current numerical criteria. But they are not acceptable when measured against non-numeric criteria. Of particular concern is the greater sediment accumulation that would occur at these sites, the potential for accelerated eutrophication because of nutrient build-up, and the proximity of these sites to important, intensively utilized resources.

In conclusion, the risk associated with attempting to place an outfall at the shoreward sites is not in the best long-term interest of MWRA. To attempt to fit the outfalls into these sites would place a greater burden and reliance on MWRA activities in the area of toxics and nutrient control and would provide little margin of safety for future changes in water quality requirements. If it should ever come to pass that a more extended outfall (in the case of the nearshore sites) were deemed necessary, the Authority would then incur a significant financial penalty.

The outfall structure should be built as a deep rock tunnel. In all cases, the diffuser, which provides initial mixing of the discharge, should consist of the final 1.25 miles of tunnel, from which 80 riser pipes extend from the tunnel to the sea floor. The underground portion of the diffuser will simply be an extension of the tunnel itself. The riser pipes will be constructed by drilling approximately four-foot-diameter shafts down to the tunnel. Special caps will be provided at the seabed to discharge the effluent into the marine environment. The diffuser section is shown in Figure 5-2.

5.5 ALTERNATE PLAN

The impacts of the Alternate Plan effluent are similar to the impacts of primary effluent from the recommended base plan, mainly because the effluent quality is similar. While the number and type of EPA Criteria expected to be exceeded is the same for the Alternate Plan effluent as for Base Plan effluent, the percent reduction needed to meet the criteria is lower for the Alternate Plan. With regard to Massachusetts Water Quality Standards, at Site 4.5 the dissolved oxygen standard may be exceeded during periods of stratification under a resuspension event. This, too, is similar to primary treatment, although the magnitude of the DO depression is less for the Alternate Plan.

The impacts on primary productivity would be somewhat greater for the Alternative Plan than for primary effluent. However, the impacts on the marine environment, specifically on the food web, would be indistinguishable. The impacts to fisheries would be minimal for the Alternate Plan.

Overall, the impacts of the Alternate Plan on the marine environment and on human health would be minimal.

SEA LEVEL EL. 105 FT

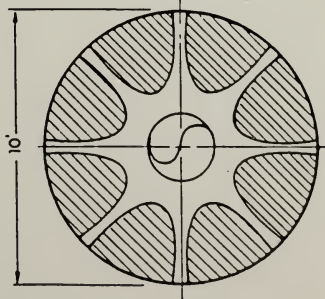
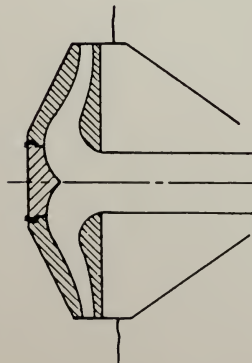


6600 FT. DIFFUSER
80 EQUALLY SPACED RISERS

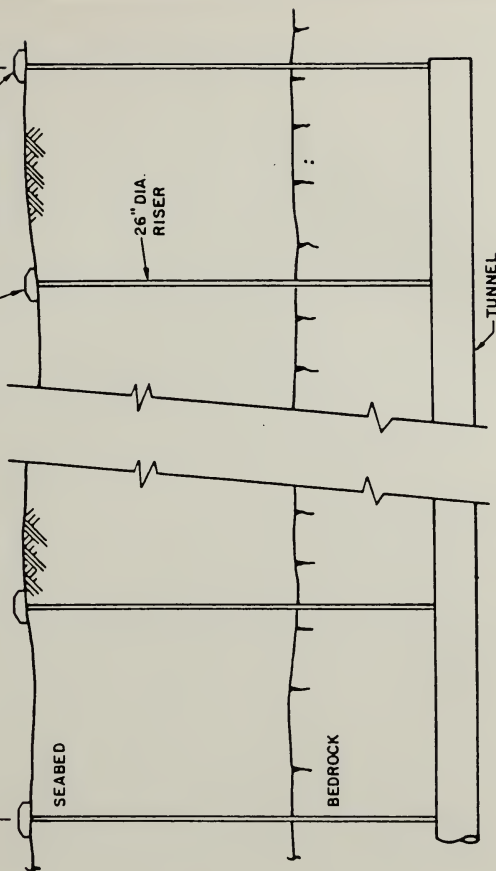
DETAIL A

RISER CAP
(TYP 80 PLACES)

DETAIL A
SECTION
N.T.S.



PLAN OF RISER CAP
N.T.S.



0 60 120
SCALE - FEET

FIGURE 5-2
TYPICAL DIFFUSER CROSS SECTION

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6.0 EARLY SITE PREPARATION

6.1 INTRODUCTION

The limited size of Deer Island, maintenance of the existing treatment plant operation, overall court-imposed schedule milestones, environmental and institutional factors, large volumes of materials that must be moved, large size of the new primary and secondary treatment facilities, and the hydraulics of the treatment system combine to produce a complex total site development plant.

Early site preparation, the initial phase of this overall plan, consists of those construction activities which must be initiated at an early date to prepare Deer Island for the late 1990 start of construction of the new treatment facilities. Failure to begin the early site preparation activities in late 1988 will impact the remaining site preparation activities and thus construction of the primary treatment facilities.

The major activities of early site preparation include protection of the existing plant outfall pipes followed by the on-site relocation of existing grit and screenings to a secured landfill, the excavation of a sizeable segment of the central drumlin, and the creation of visual and noise barrier landforms. Demolition of the existing water reservoir atop the central drumlin and demolition of the Fort Dawes structures will also be accomplished.

Environmental impacts will be mitigated by various noise, visual, odor, traffic, and land-use restrictions. Costs and schedule will be optimized by adherence to the recommended plan.

6.2 RECOMMENDED PLAN

The recommended plan for early site preparation is described below:

The first early site preparation activity required to be accomplished is the installation of necessary additional protection for the several existing outfall pipes buried along the west side of Deer Island between the plant and the harbor. Without support or load transfer modifications, repeated heavy construction loads and/or additional loads due to proposed landform construction over the pipes near the southern end of the island will subject the pipes to stresses that may exceed the allowable limits. Identification of the sources and magnitudes of the additional loads early on in the design phase of the project is critical to allowing the design of any required modifications to proceed.

Removal, transport and disposal of the existing 85,000 yd³ of grit and screenings is another activity that requires a very early start. The process involves the development of a new landfill south of the existing grit and screenings waste areas followed by excavation and disposal of the waste. In order to mitigate odors associated with the transfer process, the activity will be limited to the cooler months of the year.

Since only two colder weather construction periods will be available (1988-89 and 1989-90) to complete the transfer of this waste prior to the start of the new primary plant construction, early planning, design and contract award are essential. Two on-site alternatives were evaluated for grit and screening disposal: transfer of untreated waste to a secure landfill; or chemical stabilization of the waste by the Chemfix process. While both alternatives are feasible, the disposal by the secure landfill concept is the recommended alternative since it can be accomplished in a shorter time, at a lower cost, and with less environmental impact than the chemical stabilization process.

Removal of a portion of the central drumlin is also an essential part of the recommended early site preparation plan. Not only is the excavation of over 1.6 million yd³ required to establish the 125 ft grade elevation for construction of the primary treatment plant, but drumlin soils are to be used in landform creation and as stabilizing and cover material for the grit and screenings area.

Since the on-island piers will not be operational until late 1989, the inability to remove and dispose of excavated drumlin soils from the area which will be needed for new primary plant construction is a constraint that is best circumvented by the use of existing prison property. The existing use of Deer Island is shown in Figure 6-1.

The recommended plan, shown in Figure 6-2, is based on obtaining complete access to the Deer Island House of Correction property by 1989. Access to prison property allows the creation of permanent noise and visual barrier landforms which are preferable to the phased construction of barriers that will have to occur if prison property access is unavailable until late 1991. Complete prison property access also eliminates the need to implement special costly mitigation measures that may be required to minimize the impacts of construction on the inhabitants of the prison.

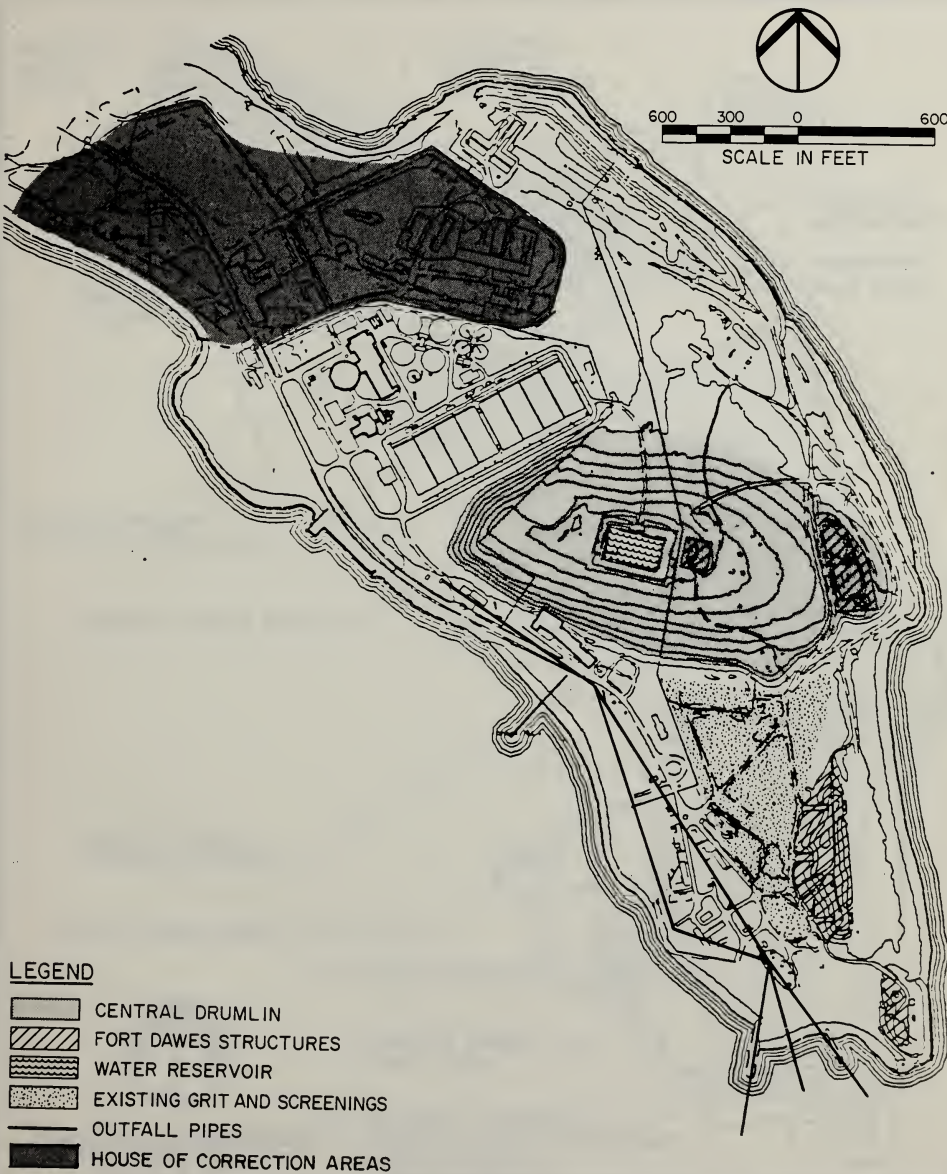
The decommissioning and removal of the cooling water reservoir built into the top of the drumlin must be accomplished before the early site preparation phase of drumlin excavation can be completed. The recommended plan includes the provision of an alternate cooling system back-up to the primary service water system.

Other activities to be completed during the early site preparation period are demolition of Fort Dawes, relocation of the existing island access facilities (including the roadway, parking lot, the security station and fencing) and the clearing and grading of the five-acre area for the concrete batch plant.

The estimated project cost of the recommended plan for early site preparation work is \$17.4 million.

6.2.1 ENVIRONMENTAL CONSIDERATIONS

The environmental impacts of Early Site Preparation will be minimized as a result of several major mitigation steps associated specifically with the recommended plan.



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**FIGURE 6-1
EXISTING DEER ISLAND LAYOUT**

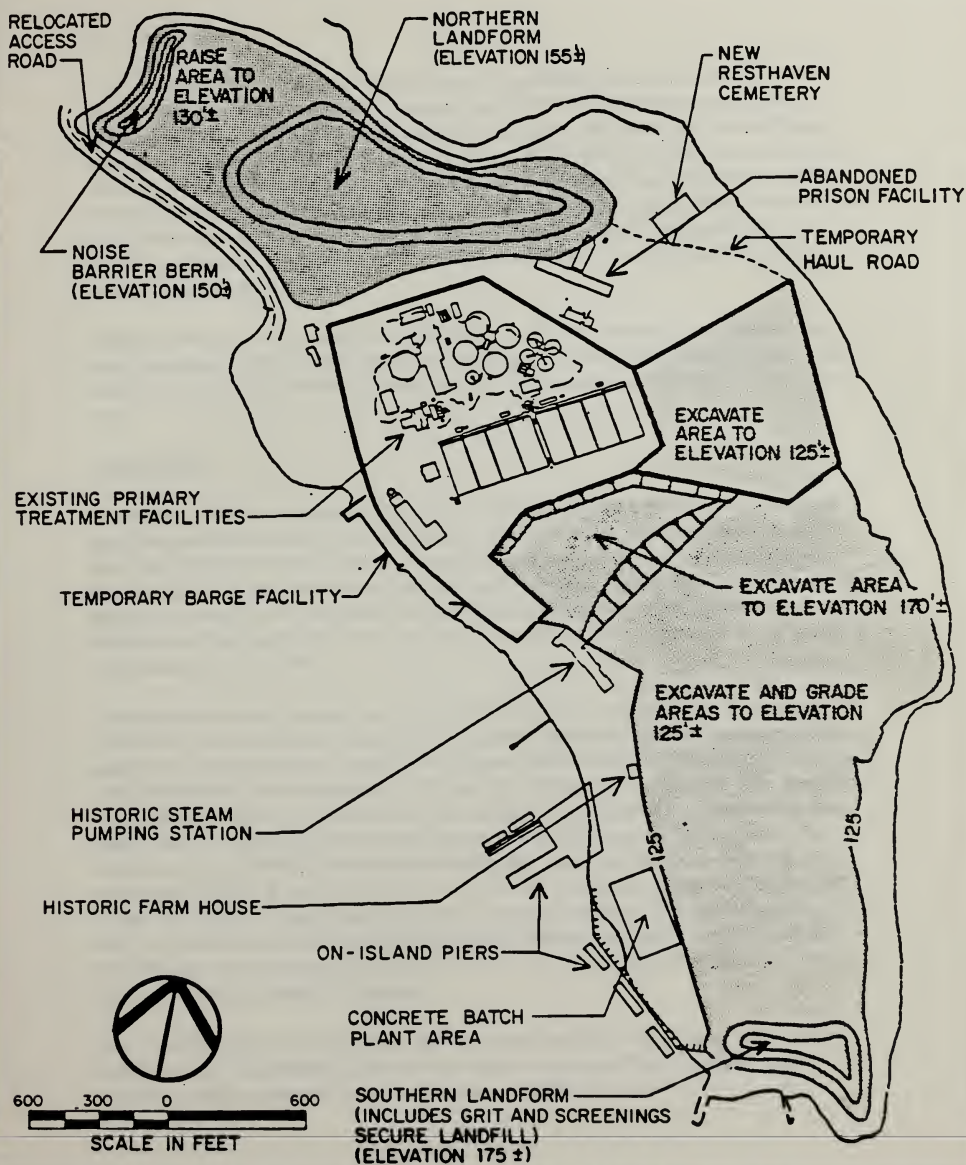


FIGURE 6-2
EARLY SITE PREPARATION FOR
DEER ISLAND - RECOMMENDED PLAN
(DECOMMISSIONED PRISON)

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Air Emission Control

The excavation of the grit and screenings disposal areas have the potential to create odors. These potential odors are likely to be detectable only within the immediate vicinity of the construction areas. To minimize the potential for such odors, the excavation and landfilling of these materials will be performed between the months of November and March (1988-89 and 1989-90). Furthermore, the landfill surface area and frequency of exposure of the grit and screenings will be minimized by placing the grit and screenings in approximately one-foot-thick layers, each separated by a layer of soil (approximately 6 in to 12 in) for cover. The frequent placement of soil cover material will improve the stability of the landfill material and aid in odor control.

Fugitive dust from soil excavation and filling activities will be controlled as required by the use of sprinkling trucks. Potable water can be pumped to storage tanks during off-peak hours if sprinkling water requirements are found to place an unusually high demand on the existing supply.

Noise Control

Construction activities generating off-island noise will be minimized by the early building of landforms across the narrow width of the north end of the island, using drumlin-excavated soils. This mitigation activity, however, is itself a noise generator. To minimize the noise levels generated by the construction of the northern landforms, construction in these northern areas of the island will be restricted to one-shift, daytime operations. The complete construction of the landforms will require approximately 350 work days beginning in late 1988 and extending through 1990.

The dominant sources of noise from this activity will be the trucks delivering the drumlin material, the bulldozers and scrapers used to shape the landforms, and the compactors to be used on the north end of Deer Island. The expected initial sound level for construction of the noise barrier berm is approximately 61 dBA at Tafts Avenue on Point Shirley. For construction of the noise barrier berms, special quiet-wheeled bulldozers will be used, supplemented by a mobile crane. Construction of this noise barrier will take approximately one month. By keeping as many activities behind the berm as possible, the anticipated noise level will be reduced to 51 dBA. If the noise barrier berm were not created and standard equipment and normal construction methods were used, the sound level throughout this activity would be 66 dBA. Landfilling construction activities required to complete the raised, northern platform area will generate an estimated noise level of 51-57 dBA at Point Shirley, depending upon the degree of shielding provided by the berm.

Once completed, the noise barrier berm and northern landforms will serve as noise barriers against the sound levels which could be expected at the nearest off-site residence from subsequent early site preparation and construction activities.

In the event that the Deer Island House of Correction facility will not be vacated until as late as the end of 1991, consideration has been given to mitigating the noise levels associated with earthmoving activities during early site preparation. Noise projections for these activities indicated that, because of the sound isolation characteristics of both the existing buildings and the proposed temporary modules for the House of Correction, the noise from earthmoving will be less than 55 dBA in all buildings. Alternatively, temporary noise barrier walls could be constructed between the construction haul road and the new recreation yards adjacent to the Hill Prison, to control earthmoving noise to less than 55 dBA within the recreation yards.

Historical and Archaeological Sites

None of the construction activities planned for early site preparation will displace or directly affect any of the historic structures on Deer Island. Early site preparation activities, as shown in Figure 6-2, will be in proximity to the steam pumping station, the farmhouse, the new Resthaven Cemetery, the Hill Prison and the Superintendent's House. Measures required for protecting these resources will be identified in a Memorandum of Agreement between the Massachusetts Historical Commission, MWRA and EPA. It is expected that, during early site preparation, the buildings will be protected against destruction or further deterioration. Earthmoving equipment will not be used closer than the concrete wall at the back of the farmhouse. Shoring of the steam pumping station where it backs onto the central drumlin may be necessary. Openings in the buildings will be closed with plywood.

Traffic

Daily traffic impacts from early site preparation activities will be controlled as a result of mitigation measures including on-site placement of excavated soils, barging of certain materials to the site, and off-peak hour scheduling of work shifts for construction workers. The construction equipment required will be delivered to the site where it will remain for the duration of this phase of the project. The vehicular traffic associated with construction personnel involved in early site preparation will average 26-46 round trips per day with a peak of 55 to 65 trips per day. Additional daily truck traffic to support on-site activities and to provide early site preparation materials will average only 2-3 round trips per day. The 17,000 yd³ of sand associated with the leachate collection system for the new landfill will be barged to Deer Island directly. Approximately 20 barge loads over a 2-3 month period will be required to complete delivery of this material. Barge mooring dolphins and a crushed stone pad will be provided at the barge unloading area to permit delivery of this sand.

Terrestrial and Aquatic Ecosystems

Impacts on the local terrestrial and aquatic ecosystems will be minimal. A majority of the present day site is either used for urban activities or is covered with a scrub growth of coarse grasses and brush. None of the faunal species displaced as a result of vegetation removal, particularly from the central drumlin, are endangered, threatened, or otherwise unique. There are no native biological communities in the service water reservoir.

Because of the extensive surfaces which will be cleared, grubbed, and graded during early site preparation, a mitigation program will be necessary during construction to control erosion and prevent sedimentation into adjacent areas.

Double lining of the secure landfill for grit and screenings will prevent leachate contamination of the island and harbor waters.

Modifications which will be made to an existing rock bulkhead wharf, to allow for off-loading of sand from barges, will have a minimal impact on marine resources due to the limited nature of these construction activities.

Power Needs

The activities associated directly with early site preparation will not place any significant demands on the site power supply. An increase in the electrical power demand during the early site preparation period will result from other construction activities, such as the construction of pier facilities, interim sludge dewatering, construction of temporary shelters, lighting and miscellaneous demands.

Quantity and Quality of Spoils

Approximately 1.6 million yd³ of drumlin excavated material and 85,000 yd³ of grit and screenings will be moved during the early site preparation period.

This material will remain on-island to construct the berms/landforms needed to reduce visual and noise impacts. Approximately 50,000 yd³ from the Fort Dawes and reservoir demolition will also remain on-island as backfill and berm material.

Costs

Federal and state grant applications for up to 90 percent of the \$17.4 million early site preparation costs will be filed to minimize the financial impacts of this project. Annual operating costs of the constructed facilities are expected to be minimal.



7.0 INSTITUTIONAL CONSIDERATIONS

7.1 PROJECT SCHEDULE

Recommended Base Plan

Institutional Considerations identifies the permitting, program management, financing, human resources and regulatory requirements for constructing and operating the recommended facilities within the schedule entered by the Federal Court. The analysis includes a review of the court-ordered target dates and recommends any changes in the schedule that are deemed necessary.

The target dates entered by the Federal Court for the construction of the treatment facilities, outfall and inter-island wastewater conveyance system are as follows:

o	Initiate construction of new primary treatment facilities	12/90
o	Complete construction and commence operation of new primary treatment facilities	7/95
o	Initiate construction of outfall	7/91
o	Complete construction of outfall	7/94
o	Initiate construction of inter-island wastewater conveyance system	4/91
o	Complete construction of inter-island wastewater conveyance system	12/94
o	Initiate construction of secondary treatment facilities	during 1995
o	Complete construction of secondary treatment facilities	during 1999

The target dates formed the initial basis for developing the preliminary Summary Project Construction Schedule shown in Figure 7-1. This preliminary schedule shows a logical way of constructing the secondary treatment facilities in accordance with acceptable construction methods and practices. The schedule recognizes the project's complexity in terms of limited site availability, the large quantities of excavated materials, and the need for water transport of vast amounts of equipment, personnel and materials. The schedule includes limited provisions for such foreseeable risks as weather, but it does not address such events as worker disputes, strikes and Acts of God. These acts, and their impacts on the schedule, will be identified, recorded and monitored by the Program/Construction Management team retained by the Authority to manage the day-to-day project activities.

The schedule also illustrates the division of the major construction activities into manageable construction packages. The schedule reflects the anticipated permitting, agency review,

THE HISTORY OF THE

REIGN OF

CHARLES THE FIRST

IN WHICH ARE CONTAINED THE
MOST IMPORTANT AND INTERESTING
PARTS OF HIS REIGN

FROM THE DEATH OF JAMES THE FIRST
TO THE DEATH OF CHARLES THE FIRST

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THE DEATH OF CHARLES THE FIRST
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AT WHITE CHURCH
IN LONDON
BY
JOHN BURNET
BISHOP OF SALISBURY
AND
OF THE CHURCH OF ENGLAND
IN THE YEAR 1678
LONDON
PRINTED BY J. STURGEON
AT THE SIGN OF THE SHIELD
IN ST. MARTIN'S LANE
NEAR CHURCH LANE

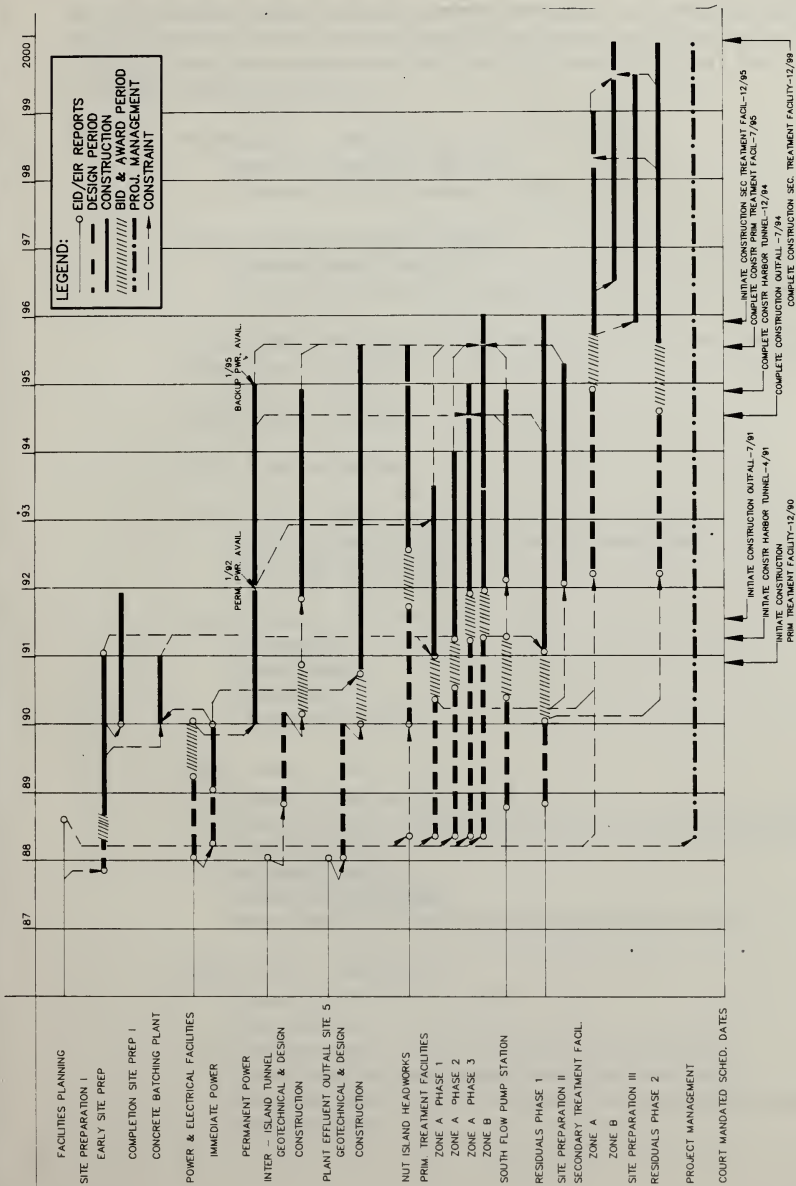


FIGURE 7 - 1
SUMMARY OF PROJECT CONSTRUCTION SCHEDULE

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design, bid and award periods for each construction package. The design, bid and award periods for each construction package are phased to allow for the necessary coordination and monitoring of the many contractors to be working on Deer Island at the same time, and to facilitate the ferrying of workers and construction materials from the off-island pier facilities. The preliminary construction packages are:

- o Site Preparation I, 1988-1991
 - Early Site Preparation, 1988-1990
 - Completion of Site Preparation I, 1990-91
- o Power and Electrical Facilities, 1988-1995
 - Immediate Power, 1988-1990
 - Long Term/Permanent Power, 1988-1995
- o Nut Island Headworks, Inter-Island Wastewater Conveyance Tunnel, and South System Pumping Station, 1992-1994
- o Effluent Outfall, 1991-1995
- o Primary Treatment Facilities

Zone A, Phase 1 -- 1991-1993

- Main Pump Station and Winthrop Terminal Modifications
- North System Force Main

Zone A, Phase 2 -- 1991-1993

- Grit Facilities
- Control Building
- Odor Facility
- Administration Building

Zone A, Phase 3 -- 1992-1994

- Primary clarifier batteries A and B
- Temporary primary conduit connecting Selectors Zone A to the existing outfall
- Primary splitter box
- Secondary splitter box
- Primary screening facilities
- Primary sludge and scum pumping galleries, batteries A and B

Zone B, Phase 4 -- 1992-1995

- Primary clarifier batteries C and D
- Selectors Zone B
- Temporary conduit from Selector Zone B to existing outfall
- Primary sludge and scum pumping galleries, batteries C and D
- Maintenance building may be constructed earlier to provide for equipment and spare parts storage

- o Residuals Phase I, 1991-1995
- o Site Preparation II, 1992-1995
- o Secondary Treatment Facilities, Zone A and Zone B, 1995-1999
 - Secondary Treatment Facilities, Zone A, 1995-1998
 - Secondary Treatment Facilities, Zone B, 1996-1999
- o Residuals Phase II, 1995-1999

The preliminary construction schedule is predicated on the construction of complete operational treatment zones (i.e. Zones A and B) rather than on the construction of the entire treatment plant in a single project. This type of planning allows for the early completion, operational testing, and acceptance by the Authority of individual parts of the plant.

Prior to the initiation of construction of Zone A of the new primary treatment facilities, extensive site preparation activities must begin on Deer Island as early as 1988 in order to prepare a level platform for the siting of the primary clarifiers. As part of this 1988-1990 early site preparation effort, the existing outfall pipes will first be protected against heavy construction equipment and/or loads. The existing grit and screenings landfill will be excavated, stabilized as required, and hauled to a previously prepared, doubly lined, on-island disposal area at the southern end of Deer Island. A major portion of the central drumlin will be excavated to begin preparation of the level platform for construction of the primary facilities and preparation of a site for the concrete batching plant; the excess materials will be used on-island to develop visual and noise barrier landforms at the northern end of the island. Existing structures such as Ft. Dawes and the water reservoir atop the drumlin will be demolished and a new non-potable back-up service water system will be installed. The prison area will be used to begin the construction of the northern landforms. Should the prison still be in operation during 1988-90, the existing prison recreation area will be relocated to allow for the use of the existing area for the disposal of excess materials; the south area reserved for residuals facilities will be used to temporarily store the remaining excess material.

After completion of the on-island pier facilities, the remainder of the central drumlin will be excavated. By the end of 1990, the concrete batching plant will be completed, the prison facilities demolished if the prison has been decommissioned, and construction will begin on the shafts for the inter-island wastewater conveyance tunnel and the outfall tunnel.

In addition, prior to the start of the construction of the primary facilities in December 1990, installation of additional short-term and permanent power supplies will be required to meet the power needs of operating the existing treatment facility and constructing the two submarine tunnels. Negotiations are underway to meet this power need via a new 24-kvA Massachusetts Electric Company (MECO) line from MECO's Metcalf substation through Winthrop to Deer Island since Boston Edison Company (BECO) may not be able to provide this construction power via the recommended permanent 115-kv under-harbor line until mid-1991 or later.

Construction of the first phase of the permanent power facilities will begin by January 1, 1990. Completion of the first underharbor 115 kv permanent feeder from Boston Edison company's

K Street station will be accomplished by the end of 1991 to meet the power needs of the primary sludge dewatering facilities, the on-island piers, and basic plant power requirements. The second 115 kv permanent feeder from BECo's Chelsea station and the recommended combined cycle on-island power plant will be completed by January 1995 to meet the needs of the new primary facilities and to satisfy the EPA requirement for an uninterruptible supply should the tie with the utility fail.

The extensive geotechnical exploration program required to support the 1990 design of the inter-island conveyance system and outfall tunnel will begin in 1988. Based on the estimated advance rates for the tunnel boring machines, construction of the outfall tunnel must begin in 1991. This start date will allow the outfall to be operational in 1995 at about the same time that the new primary facilities are placed in service.

Construction of the inter-island conveyance system is scheduled to begin in late 1991. This tunnel will be completed in approximately three years.

The construction of the Main Pump Station and Winthrop Terminal modifications and the North System Force Main components of the primary treatment system will begin during December 1990. Construction of the new South System pump station required to lift South System flows up from the inter-island wastewater conveyance tunnel will also begin in 1990 as will the first phase of the new residuals facilities. The second phase of the site preparation efforts will begin in 1990 to prepare the central island area for the construction of the secondary facilities, construct berms in the north and east areas, and handle the outfall and inter-island tunnel spoils. Bidding and award of the construction contracts will allow the remainder of the primary treatment facilities to begin construction from early 1991 to 1992.

Construction of the Zone A primary clarifiers (A and B) and associated works will also be staggered. Phase 1 will be completed by mid-1993. Phase 2 of the Zone A primary clarifiers will be completed by the end of 1994, and Phase 3 by the end of 1994. The phased construction of the primary treatment zones will permit the early operation of the completed primary clarifiers in 1994, resulting in improved treatment and the testing of equipment during the warranty period and under actual operating conditions.

Construction of Zone B (C and D) primary clarifiers and associated works will be completed by July 1995. Operational testing of the new primary treatment facilities will continue through the remainder of 1995. The Nut Island headworks will be operational in mid-1995 when the new primary facilities are available to treat the South System flows. Phase 1 of the residuals facilities will also be available at that time.

Phase II site preparation efforts to prepare the central island area for construction of the secondary treatment facilities will be completed by the end of 1995. This will complete the major earth movement activities on the island, as well as tunnel excavation efforts. The excess materials will either be used to develop on-island noise and visual barriers, or will be transported off-island for disposal. Construction of the Zone A secondary clarifiers will begin in this central area by the end of 1995 in accordance with the court schedule.

The Zone B secondary clarifiers will begin construction in mid-1996. With the completion of the Zone B secondary clarifiers and Phase II residual facilities by the end of 1999, the new Deer Island Secondary Treatment Plant will be operational. This schedule is only achievable, however, if the following critical path activities are completed on time:

- o Implementation of the geotechnical information gathering effort in the spring of 1988 to support the design of the tunnels.
- o Initiation of the design of the new primary treatment plant facilities immediately following approval of the Facilities Plan in May, 1988.
- o Demolition and removal of the Hill Prison by 1989, or the use of the reserved residuals area for storage of excess excavated materials generated during the Early Site Preparation period.
- o Removal and reburial of the existing grit and screenings by 1990.
- o Provision of an interconnection with MECo's Winthrop grid by January 1, 1990 to meet the immediate power needs of the tunnel construction efforts.
- o Completion of the first underharbor power cable by January, 1991, and the on-island combined cycle power plant by January, 1992, to meet both construction power needs and operating power needs of the new facilities.
- o Completion of outfall construction by July, 1995, in time to receive flows from the new primary treatment facility.
- o Successful completion of permitting requirements for each project component. Critical among the permitting issues are the need to immediately initiate permitting activities for early site preparation and utilities supply, and the need to develop a strategy for the re-use or disposal of approximately 1.3 to 1.7 million yd³ of excavated material from Deer Island. The recommended plan and the associated schedule have not taken into account the delays associated with permitting and licensing appeals. There is a commitment made to expedite and provide cooperation and coordination among agencies in order to minimize the possibility or the effects of an appeal.

In addition, to ensure that the Deer Island project meets the scheduled completion dates within the project budget, the responsibilities of the Program/Construction Management Team retained by the Authority should include developing, overseeing, coordinating, monitoring, and administering all Deer Island secondary treatment facilities contracts related to the following programs:

- o Equipment Pre-purchase -- the completion of construction on an optimum schedule may require extensive pre-purchase of critical equipment items.
- o Overwater Transportation -- upon completion of the on-island pier facilities in 1989, at least 50 percent of the estimated peak workforce at Deer Island will be transported

over water to the on-island job site via ferries from on-shore satellite parking facilities. In addition, the vast majority of construction materials and equipment, as well as operations supplies, will be transported to Deer Island by roll-on/roll-off vehicles delivered by boats and/or barges traveling between the on-shore and on-island piers.

- o Overland Transportation -- A maximum of 50 percent of the peak workforce will be bused to Deer Island from designated satellite parking areas.
- o Concrete Production -- The total demand for concrete ranges from 0.88 to 0.95 million yd³ depending on the length of the outfall. The peak demand years are 1992 through 1994, which will overlap with the peak demand years of the Central Artery/Third Harbor Tunnel Project.

The organizational approaches for providing these necessary construction support activities are outlined in Volume VII. A final determination by the Authority should await a thorough analysis by the Program/Construction Management team.

Alternate Construction Schedule

The three alternatives for the construction schedule that were considered can be summarized as follows:

Base Plan (0% Secondary in 1995, 100% Secondary in 1999 or "Sequential Construction")

Construction of the entire, new primary treatment facilities and associated works to provide primary treatment of 100% of the flow from the North and South systems by July 1995. Construction of the secondary treatment facilities are scheduled to start in late 1995 and be completed by the end of 1999.

Alternate Plan (25% Secondary in 1996, 100% Secondary in 1999 or "Concurrent Construction")

This plan would require construction of all the primary treatment facilities, and 25% of the secondary clarifier facilities, 50% of the aeration facilities and associated works to provide secondary treatment for approximately 26% of the average flow (high groundwater conditions) in 1996. By 1996 all wastewater would receive primary treatment from the new facilities. During 1994 (prior to completion of the secondaries) the completed portion of the new primaries would have capacity to provide treatment for 50-60% of the design flow with the remainder of the flow receiving primary treatment at the existing facilities. The North System flow would be treated in the new facilities beginning in 1994. South System flows would begin being treated in 1996 at the new facilities.

Alternative Plan For 50% Secondary (50% Secondary Treatment by 1996, 100% Secondary by 1999)

A third alternative, which would provide more than 20-25% secondary treatment at an earlier date, was reviewed but was not considered to be feasible. This alternative

would provide as much as 50-60% of the secondary treatment facilities at an earlier date, however it was not considered feasible for the following reasons:

Construction of any secondary treatment facilities at an early date is constrained by the need to keep the existing primary plant in service during the initial 2-3 years of construction of the secondary facilities. Construction of 50% of all secondary facilities is not feasible without removing a significant number of the existing primary clarifiers from operation. Existing primaries would need to be removed from service sometime during 1992, which is two years before any of the new primaries are available.

The addition of as much as 50% of the secondary facilities at an earlier date will produce a large quantity of secondary sludge and is likely to require implementation of a second residuals technology. Implementation of both primary and secondary sludge treatment technologies does not appear feasible by 1996.

The volume of construction materials requiring movement and the associated laydown areas are substantially increased with this alternative. The larger area under construction reduces the available area for laydown usage. This combination of factors will negatively impact the constructibility of the project and will increase the cost of construction. Rate impacts will be significantly increased by this alternative.

Figure 7-2 shows the Alternate Plan's construction schedule. The major differences in the construction schedule compared to the Base Plan construction schedule are:

Primary Treatment Zone A Phase 1 begins 4 months earlier, but is completed at the same time, in mid-1993.

Primary Treatment Zone A Phase 2 begins a year earlier in 1991, but is completed at the same time, at the end of 1994.

Primary Treatment Zone A Phase 3 begins 4 months earlier in 1991, but is completed at the same time, at the end of 1994.

Primary Treatment Zone B Phase 4 begins one year later at the start of 1993 and is completed six months later than the previous schedule, in the middle of 1996.

The Secondary Treatment Facilities Zone A has been broken into two parts Phase 1 and Phase 2.

The Secondary Treatment Facilities Zone A Phase 1 will begin three years earlier in mid-1992 and will be completed at the end of 1996.

The Secondary Treatment Facilities Zone A Phase 2 will start four months later in the beginning of 1996 and will be completed in mid-1999, six months later than the Base Plan.

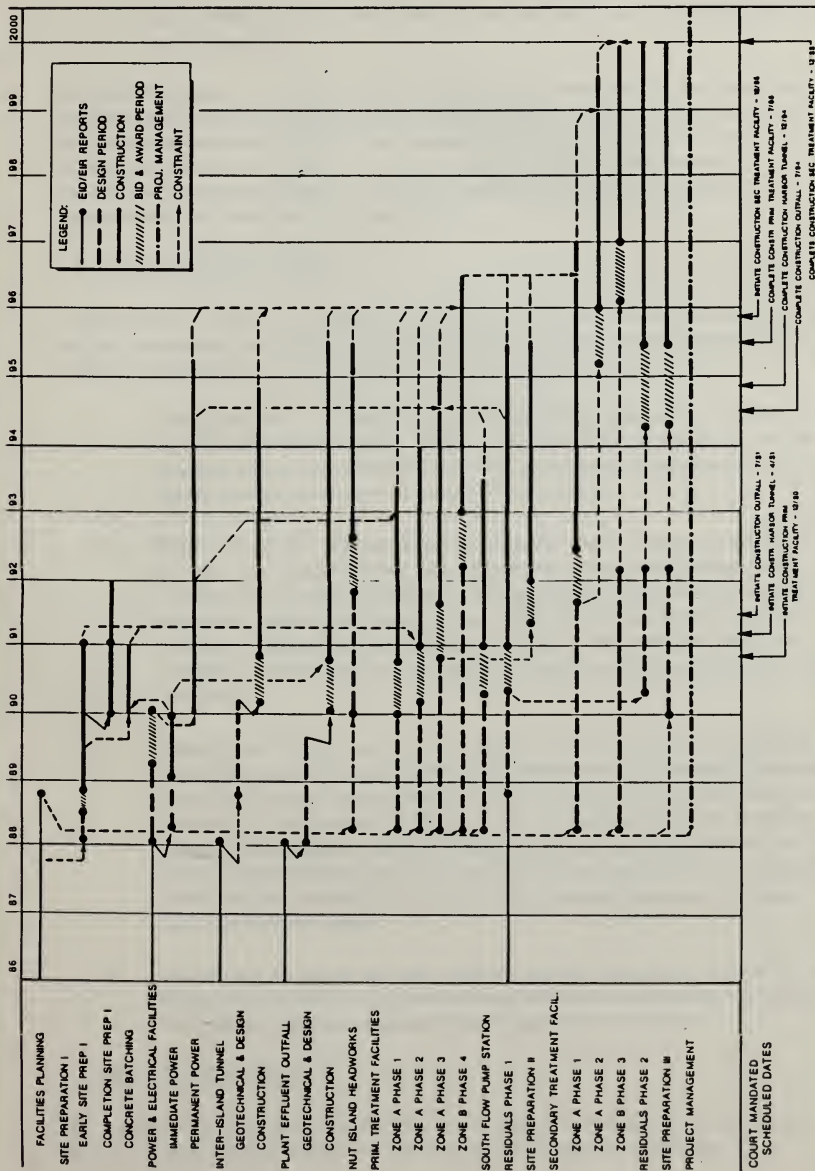


FIGURE 7 - 2
ALTERNATE PLAN CONSTRUCTION SCHEDULE

**MASSACHUSETTS
WATER RESOURCES
AUTHORITY**

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The Secondary Treatment Facilities Zone B Phase 3 will start in the beginning of 1997, four months later than under the Base Plan and will be completed on the same schedule as the Base Plan.

The schedule changes in the alternate schedule result in an extension of the final completion of the primary facilities by approximately six to twelve months. This is offset by the ability to initiate construction of a portion of the secondary facilities simultaneously with the construction of the first two phases of the primary plant. By shifting the construction resources to the secondary facilities at an earlier date than the Base Plan, a portion of the secondary facilities is available by the end of 1996.

7.2 PROGRAM MANAGEMENT

The overwhelming logistical requirements and strict court-ordered schedule associated with the facilities plan mandate that MWRA immediately expand its capability to manage large-scale, complex capital projects. The recommended steps for achieving this objective are:

- o Create and staff an in-house Program Management Unit dedicated to monitoring the Agency's most complex capital projects. The role of this unit will be to provide executive control and direction, monitor the performance of consultants and act as a liaison between consultants and other MWRA divisions.
- o Retain a Program/Construction Manager (P/CM) who will assume primary responsibility for day-to-day program management including the supervision of design, cost estimating, scheduling, permitting, value engineering, pre-purchase of equipment, engineering services during construction, facility testing and staff training. In addition, the P/CM will provide technical support for the Authority's decisions regarding contractor selection, change order control, progress payments and final acceptance.
- o Retain a Lead Design Engineer who will assume responsibility for directing the design of the primary and secondary treatment facilities including the tunnels, power plant and on-site residuals management facilities. The Lead Engineer will develop design standards, provide drawings at the 10-15 percent completion level for all facilities, prepare a final design of the priority design packages, and oversee selected designers for the other design packages. The work of the Lead Engineer will be managed from an overall program perspective by the P/CM with particular emphasis on schedule, budget and constructibility issues.
- o Request that the federal and state regulatory agencies immediately assign a full-time liaison to the MWRA's Program Management Unit to ensure effective coordination with the regulatory agencies in permitting and mitigation requirements.

7.3 PROJECT FINANCING

The construction of new facilities to clean up Boston Harbor and provide adequate sewerage service to the Metropolitan Boston area will entail a major financial commitment. In

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current-day dollars, it is estimated that new MWRA facilities related to these projects will cost approximately \$3 billion. Since construction of these facilities will continue through the rest of the century, inflation will increase the actual cost. Once the facilities are constructed, the MWRA will have the additional responsibility and cost of operating the new facilities. The funds to construct and operate these facilities, if not derived from external sources (grants or loans) must be recovered through the Authority's charges to user communities.

The financial impact analysis focuses on three major components:

- o Current Dollar Expenditures -- which describes the expenditures required annually, in current-day dollars, for construction and operation of new and existing facilities. The Capital costs are identified for the facilities included in the Deer Island Secondary Treatment Facilities Plan as shown in Table 7-1, other capital projects contained in the Authority's proposed 1988-1990 Capital Improvements Program, together with an allowance for miscellaneous divisional capital projects and allocated capital projects of the Authority's support divisions. Costs associated with future CSO projects not yet authorized are not included in this analysis.

Operating costs include the direct costs of the sewerage division, plus an allocation for other Authority operating expenses. Current MWRA operating costs are based on the FY 1988 operating budget. The existing operating costs for FY 1989 and FY 1990 are based on the MWRA's preliminary budget estimates for wages. Future year costs include the increased operating expenses associated with primary and secondary treatment, residuals management and the water transportation system.

- o MWRA Revenue Requirements -- which projects the amounts in future dollars which must be raised by charges to the user communities to retire the debt associated with the construction program and to pay operating expenses. In estimating the amounts to be raised through charges, several different variables were considered. These include economic variables, such as anticipated rates of inflation, and financial variables, such as terms and rates for bond issues and the availability of grants-in-aid and/or loans from state and federal grants.

In order to evaluate the range of effects that different assumptions about the variables might produce, a base case and four alternatives were constructed. The base case represents a prudent scenario: reasonable estimates of future economic and financial variables are made, and grants-in-aid are assumed to be available only to the extent to which these grants have already been committed to the Authority through FY 1988. Alternative 1 is similar to the base case, but assumes higher inflation and bond interest rates, plus a shorter term on the Authority's revenue bonds. Alternative 2 uses the base case assumptions, but also assumes the institution of a State Revolving Loan Program with a maximum annual loan amount of \$50 million with interest at half the normal market rate. Alternative 3 is similar to Alternative 2, but assumes a more attractive State Revolving Loan Program with zero-interest loans and \$100 million available per year. Alternative 4 is a "best likely case" scenario,

TABLE 7-1

**DEER ISLAND SECONDARY TREATMENT FACILITIES
CAPITAL COST**

	<u>Cost in Millions</u>
Nut Island Headworks and Site Restoration	\$ 39
Inter-Island Conveyance System	84
South System Pumping Station	39
North Main Pumping Station, Winthrop Terminal and North Grit Removal	69
Primary Treatment Facilities	243
Secondary Treatment Facilities	567
Disinfection Facilities	22
Power Generation and Distribution	118
Site Work	121
Potable and Plant Water	19
Administration, Maintenance and Control Buildings	64
Effluent Outfall	468
CM/LE Services	107
TOTAL	\$1,960

Note: The above costs reflect September 1987 costs and include 35 percent for engineering and contingencies. Costs do not include residuals handling facilities.

assuming lower inflation rates and a low-interest State Revolving Loan Program in conjunction with a new grant program of 25 percent, with a maximum grant amount to the MWRA in any given year of \$100 million.

- o Community Allocation/Impacts -- which investigates the impacts of the MWRA charges on users served by two user systems, the Boston Water and Sewer Commission and the Town of Needham. These two user communities were selected because they represent a fully self-sufficient local utility, and one which raises some of its wastewater expenses from tax levies. These approaches are representative of the local financing methods in use in the service territory.

The total cost of Deer Island-related projects in current dollars is \$1.96 billion with annual expenditures reaching a peak of \$291 million in FY 1993. The total current dollar value cash flow for all projects (Deer Island and non-Deer Island) is \$2.93 billion.

Table 7-2 presents a summary of cash flow projections for construction-related costs for the base case scenario and the four alternatives. This table presents the net (less grants) construction costs, the estimated amount of annual Authority revenue bond issues, the Authority's total debt since payments, and annual debt service reserve deposits.

Table 7-3 summarizes the annual revenue requirements under the base case and the alternatives. This table presents the Authority's projected annual revenue requirements including total debt service, operating costs and reserve requirements by year.

The cost of financing the annual revenue requirements (net of grants and other sources of income) will fall on the users within the MWRA service area. The increased annual sewer charges will not impact all properties to the same degree. MWRA user communities pass the Authority's charges on to their own retail customers in a multitude of ways. These methods range from full recovery of the Authority charges through the communities' retail sewer rates to full or nearly-full recovery through ad valorem property taxes.

As noted previously, the financial impact on users in two different communities were analyzed. While it is intended that the analysis be useful in determining the relative impact in all communities, it must be recognized that the number of different cost recovery mechanisms used and the diversity among MWRA member communities make a direct comparison between any two communities invalid.

The impacts presented for the two communities, Boston and Needham, are intended to show the total cost of providing wastewater service in each community through 2005. As such, the costs of each community's wastewater utility operations include the projected MWRA charges as well as projections of the communities' current local operating and capital (including debt) costs. The analysis of the future costs and needs in the communities is necessarily not as extensive as that performed for the Authority, and thus may understate the communities' future local costs.

TABLE 7-2

COMPARISON OF NET CAPITAL CASH FLOW
(Base Case and Alternatives)
(Values in \$1,000)

	PT	1988	1989	PV	1990	PT	1991	PV	1992	PT	1993	PT	1994	PV	1995	PT	1996	PV	1997	PT	1998	PT	1999	PV	2000	PT	2001	PV	2002	PT	2003	PV	2004	PT	2005	
Base Case	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	
Alternative 1	59,365	86,581	163,059	282,418	417,292	543,347	486,336	348,682	363,724	460,808	486,168	486,168	448,108	448,108	221,076	221,076	221,076	33,914	33,914	35,948	38,105	40,332	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	
Alternative 2	59,719	81,356	182,855	328,207	502,682	678,576	630,295	468,947	507,637	667,404	730,703	730,703	698,915	698,915	357,825	357,825	357,825	56,962	56,962	62,659	68,925	75,817	81,399	81,399	81,399	81,399	81,399	81,399	81,399	81,399	81,399	81,399	81,399	81,399	81,399	
Alternative 3	59,365	86,581	163,059	282,418	417,292	543,347	486,336	348,682	363,724	460,808	486,168	486,168	448,108	448,108	221,076	221,076	221,076	33,914	33,914	35,948	38,105	40,332	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815	42,815
Alternative 4	58,621	77,143	137,727	233,442	333,947	424,158	363,103	254,025	285,269	367,343	375,891	375,891	337,707	337,707	148,823	148,823	148,823	11,441	11,441	27,022	28,374	29,792	31,282	31,282	31,282	31,282	31,282	31,282	31,282	31,282	31,282	31,282	31,282	31,282	31,282	

TABLE 7-3

COMPARISON OF ANNUAL REVENUE REQUIREMENTS
(Base Case and Alternatives)
(Values in \$1,000)

	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT	PT
	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Base Case	152,427	201,189	286,310	391,731	460,599	519,093	568,501	630,719	693,186	776,384	837,087	857,269	865,303	883,259	902,158	922,001	941,844	961,687	981,530
Alternative 1	169,050	239,346	347,178	496,565	605,072	696,514	785,316	900,599	1,022,526	1,168,890	1,286,786	1,324,250	1,366,864	1,403,386	1,460,143	1,515,467	1,570,791	1,626,115	1,681,439
Alternative 2	151,061	198,456	279,634	385,142	450,296	506,974	554,761	615,451	676,784	758,337	817,785	835,574	855,372	872,257	894,261	917,396	940,531	963,666	986,801
Alternative 3	147,007	190,348	262,615	366,015	426,725	478,993	522,467	578,938	636,143	713,661	765,161	786,038	801,870	820,731	841,649	863,633	885,617	907,601	929,585
Alternative 4	137,503	173,874	232,752	306,044	341,473	377,593	404,901	440,453	471,807	524,882	565,642	574,177	584,653	591,547	602,850	614,532	626,214	637,896	649,578

Figure 7-3 presents the annual sewer bill (not including water) for a typical single-family residential customer in Boston under the base case and alternative assumptions. In the base case, the fee will increase from the current \$118 per year to approximately \$798 per year by the year 2005. In the "best case" the fee will increase from \$118 to approximately \$544; in the "worst case", the fee rises from \$118 to about \$1321. In evaluating this impact, it must be remembered that this sewer bill will be paid in inflated, year 2005 dollars.

Figure 7-4 presents the estimated future wastewater costs (sewer bill plus property tax) for a typical residential user in Needham. This analysis reflects Needham's policy of wastewater expense recovery whereby the amount of the last MDC assessment prior to the creation of the MWRA, plus all local wastewater-related expenses, are recovered through the Town's property taxes.

Under the base case assumptions, the fee for a typical residential user in Needham will increase from \$125 to approximately \$984. In the "best case," the fee will increase from approximately \$125 to approximately \$653; in the "worst case" the fee will use from \$125 to over \$1650.

All costs and financial impacts have been presented in terms of inflated dollars to account for expected increases in construction and operating costs in future years. Accordingly, all projected sewer assessments and retail bills would be paid in future dollars as well. To determine the impact in current-day dollars, an analysis was made assuming no inflation. Annual (sewer only) bills would increase to approximately \$450 per year for a single-family user in FY 2005 in Boston and Needham under the base case assumptions with no inflation.

While construction and operation of new facilities to clean up Boston Harbor will be a significant cause in the projected increases in MWRA assessments and retail sewer bills, it must be acknowledged that these existing charges would increase due to inflationary impacts. To determine the impact of the Boston Harbor Clean-Up Program, an analysis of projected assessments and retail sewer bills was made assuming no new construction other than the projected administrative, interceptor and pumping station projects, and no new operating costs associated with new facilities. Without the required construction projects and associated operating costs, retail sewer bills in Boston and Needham would still increase to approximately \$250 for a single-family user under the base case assumptions.

To alleviate the financial burden on local ratepayers, the following actions are recommended:

- o Creation of a State Revolving Fund (SRF) which will supply low-interest loans for financing wastewater plants. The SRF would be capitalized with an 80 percent federal contribution (as authorized in the 1987 Clean Water Act) and a state contribution of 20 percent.
- o Re-authorization of the State Construction Grants Program which currently provides financing for 55 percent (or more) of eligible project costs.

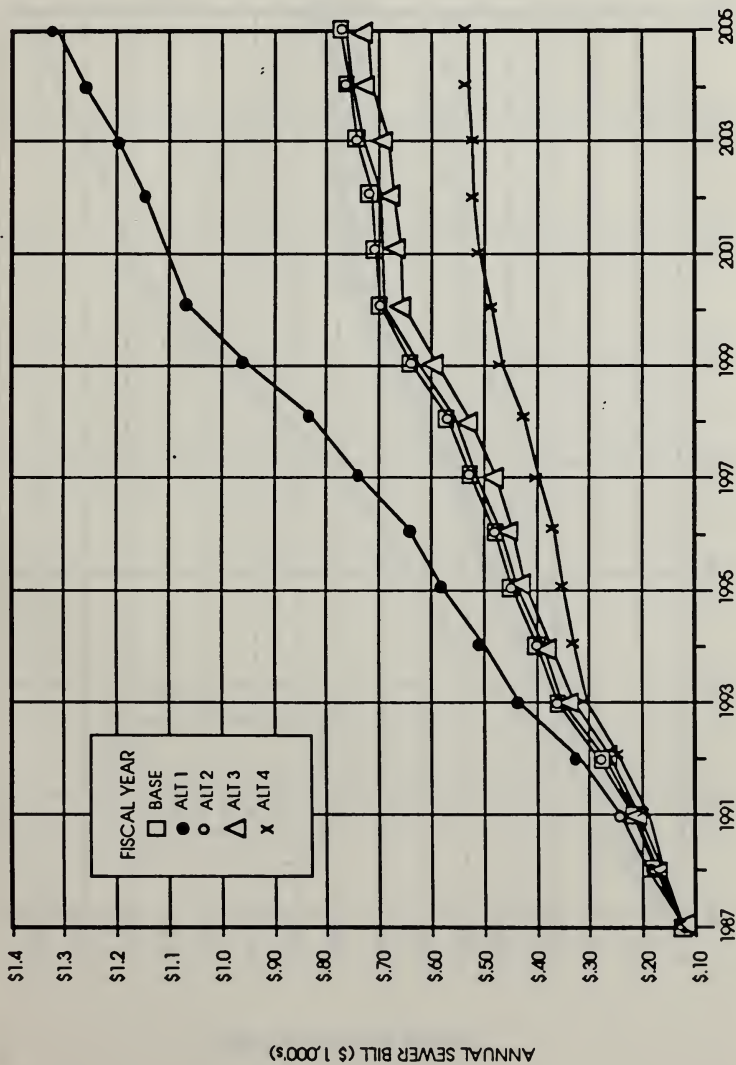


FIGURE 7 - 3
COMPARISON OF 1 FAMILY SEWER BILLS
BOSTON WATER & SEWER COMMISSION

MASSACHUSETTS WATER
RESOURCES AUTHORITY

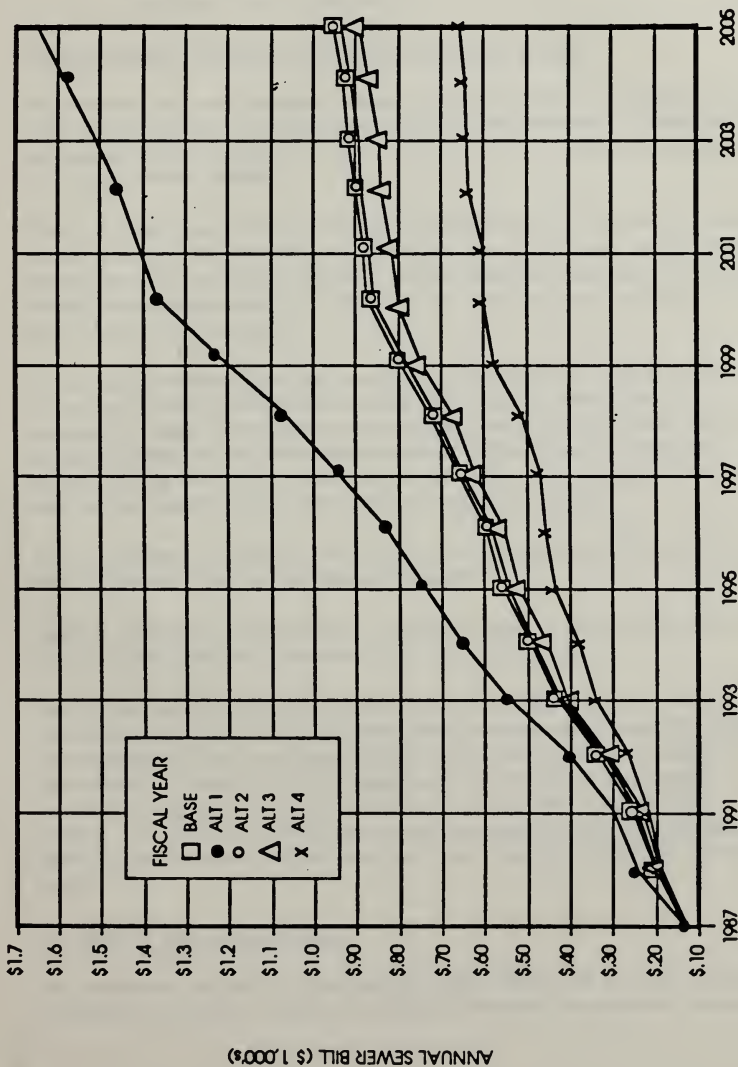


FIGURE 7 - 4
COMPARISON OF 1 FAMILY SEWER BILLS
TOWN OF NEEDHAM, MASSACHUSETTS

MASSACHUSETTS WATER
RESOURCES AUTHORITY

- o Expedition of early site preparation and design activities to maximize the use of the existing Federal Construction Grants program prior to its expiration in FY 1990.
- o Use of value engineering and construction innovations to maintain cost control through the design and construction phases.

Financial Analysis - Relating to the Alternative Construction Schedule

The alternative construction schedule includes an earlier completion of construction, and as a result, earlier operation of a portion of the secondary treatment facilities. Consequently, the financial impacts presented in Section 7 of Volume VII will change somewhat under the alternate construction schedule.

Table 7-4 presents the current dollar cash flow projections under the alternative schedule. In general, the total construction costs are quite similar, with the alternative schedule costing approximately \$26 million more. However, with the accelerated construction of some secondary facilities, annual construction costs will be somewhat higher during the mid-1990s and lower toward the end of the century.

As a result of the different cash flow under the alternative schedule, inflationary increases in construction costs will have a different impact on the overall, inflated costs of construction. Because some facilities would be constructed more quickly under the alternative schedule, inflation will not increase the cost of these facilities as much. While net construction costs under the alternative plan are some \$19 million less than those under the basic plan, the costs for various years in the mid-1990s will be higher.

Table 7-5 presents a comparison of the annual revenue requirements of the cash flow under the base and alternative financing and inflation assumptions.

Table 7-6 presents the projected impact on the Boston Water and Sewer Commission's sewer rates. Table 7-7 presents the same information for the Town of Needham.

Table 7-8 summarizes the financial comparison of the base plan and the alternate plan for the base financial case. Capital costs, in current dollars, increase approximately \$26 million under the alternate plan; but when the costs are inflated there is actually a decrease of approximately \$19 million under the alternate plan. This decrease is due to capital expenditures being made earlier in the schedule, therefore, offsetting the effects of inflation. Also, under the alternate plan, the user rate impacts of the project are noticed earlier but the user impacts stabilize earlier and show a moderate decrease over the base plan impacts.

7.4 HUMAN RESOURCES NEEDS

The best-planned, designed and constructed wastewater facilities will not perform properly unless staffed by qualified, adequately compensated, dedicated and appropriately trained and

MWRA CASH FLOW ANALYSIS
CURRENT DOLLAR CASH FLOW PROJECTION - ALT. SCHEDULE
(VALUES IN \$1000)

CONTRACT	FY 1988	FY 1989	FY 1990	FY 1991	FY 1992	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	TOTALS
Early Site Prep	5,656			5,656															11,312
Ball-Site Prep 1				5,228															10,456
Power & Elec. Facil.			9,431	18,863	14,120	9,977	9,977	9,977											72,445
Mut. Road, Tunnel, PS					12,156	37,242	37,242	24,485											111,725
Outfall		36,500	73,000	73,000	73,000	73,000	73,000	73,000	36,500										438,000
Prim. Treat-2AP1A2			47,423	60,004	60,004	60,004	12,575												180,012
Prim. Treat-2AP3				21,226		43,652	43,652	43,652											152,782
Prim. Treat-2BP4				16,651	33,303	33,303													116,560
Site Prep. 2			5,120	10,240	10,240	10,240													35,839
Secoa. Treat-2A1				41,722	41,722	41,722													187,750
Secoa. Treat-2A2A2B																			343,480
Site Prep. 3			20,317	23,340	24,995	28,152	27,151	7,687											62,648
Engineering Services	1,000	18,824	20,317	23,340	24,995	28,152	27,151	7,687											170,878
CM/IE Services	2,000	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	8,161	99,929
Other																			0
Other																			0
Other																			0
Other																			0
TOTALS - 01	5,000	32,640	80,065	176,020	225,410	324,801	297,022	252,227	149,798	113,275	136,715	136,715	60,327	0	0	0	0	0	1,994,016
NON-01																			0
Residuals-Site Acquis.			13,335	6,721	4,597														24,753
Residuals-1995 A/E-Other			4,000	5,500	5,500														15,000
Residuals-1995 Construct.				26,125	51,125	51,125	51,125	26,125											194,500
Residuals-2000 A/E-Other					6,600	6,600	6,600	6,700											19,900
Residuals-2000 Construct.						34,173	68,347	68,347	34,173										205,940
Interact. PS-Grants	4,770	9,682	11,340	19,835															45,827
Wellisley Interceptors	21,469	14,760	6,265																42,514
Brain/Weymouth Int.	200	5,365	5,435	10,395	5,330														31,855
New Weymouth Int.	787	1,493	9,200	9,350	9,200														30,030
SHP & Fresno Siphon & Quincy P.	2,615	632	1,365	5,500	5,500														15,673
Adams/Other			15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	240,000	
On Shore/On Isl. Piers	1,900	17,210	15,113																34,223
Transport. Costs			2,800	7,500	6,816	5,904	6,812	5,596	5,129	3,923	3,866							53,152	
Transp. Site Cost	47,170	9,300																	56,470
TOTALS NON-01	53,840	61,283	83,898	76,822	82,683	92,059	84,867	53,231	61,269	89,476	87,270	52,039	15,000	15,000	15,000	15,000	15,000	15,000	988,737
GRAND TOTALS	58,840	93,923	163,963	252,842	308,093	420,860	381,889	305,468	211,067	201,751	223,985	189,755	75,327	15,000	15,000	15,000	15,000	15,000	2,982,753

**COMPARISON OF ANNUAL REVENUE REQUIREMENTS - ALT. SCHEDULE
(BASE CASE AND ALTERNATIVES)
(VALUES IN \$1000)**

	PT	PV	FY	1991	1992	1993	1994	1995	1996	PY	PT	FY	2000	2001	PY	PT	FY	2003	2004	PT	FY	2005
Base Case	155,472	205,151	285,316	399,301	476,851	551,335	599,720	662,548	718,341	787,689	832,655	847,805	884,845	878,406	897,710	877,560	897,710	917,560	917,560	897,710	877,560	897,710
Alternative 1	165,682	241,096	345,997	500,185	625,786	734,810	830,191	935,477	1,044,502	1,154,502	1,264,488	1,374,471	1,484,454	1,594,437	1,704,420	1,814,403	1,924,386	2,034,369	2,144,352	2,254,335	2,364,318	
Alternative 2	151,105	190,939	278,897	390,917	466,633	539,814	586,174	631,471	676,767	722,062	767,357	812,652	857,947	903,242	948,537	993,832	1,039,127	1,084,422	1,129,717	1,175,012	1,220,307	
Alternative 3	147,051	191,423	264,250	371,717	442,939	511,161	553,752	602,842	651,932	701,022	750,112	799,202	848,292	897,382	946,472	995,562	1,044,652	1,093,742	1,142,832	1,191,922	1,241,012	
Alternative 4	137,522	232,998	312,330	350,514	400,248	425,415	465,799	497,104	535,408	573,712	612,016	650,320	688,624	726,928	765,232	803,536	841,840	880,144	918,448	956,752	995,056	
Alternative 5	137,522	232,998	312,330	350,514	400,248	425,415	465,799	497,104	535,408	573,712	612,016	650,320	688,624	726,928	765,232	803,536	841,840	880,144	918,448	956,752	995,056	

TABLE 7-6

COMPARISON OF 1 FAMILY BWSC RESIDENTIAL USER'S SEWER BILL - ALT. SCHEDULE
BASE CASE AND ALTERNATIVES

	1988	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Base Case	\$118	---	\$217	\$279	---	\$455	\$484	\$522	\$572	\$616	\$672	\$709	---	---	---	---	---
Alternative 1	\$118	\$176	\$217	\$279	\$357	\$455	\$484	\$522	\$572	\$616	\$672	\$709	\$720	\$741	\$756	\$775	\$794
Alternative 2	\$118	\$191	\$249	\$321	\$451	\$548	\$602	\$712	\$798	\$885	\$986	\$1,058	\$1,095	\$1,137	\$1,181	\$1,231	\$1,286
Alternative 3	\$118	\$175	\$214	\$275	\$361	\$419	\$476	\$513	\$561	\$604	\$659	\$695	\$712	\$731	\$748	\$769	\$791
Alternative 4	\$118	\$172	\$207	\$264	\$347	\$401	\$455	\$499	\$535	\$575	\$626	\$660	\$676	\$694	\$710	\$731	\$752
Alternative 5	\$118	\$163	\$192	\$227	\$299	\$331	\$387	\$407	\$419	\$444	\$480	\$504	\$512	\$522	\$529	\$540	\$551

TABLE 7-7

COMPARISON OF 1 FAMILY NEEDHAM RESIDENTIAL USER'S SEWER CHARGES - ALT. SCHEDULE
BASE CASE AND ALTERNATIVES

	1987	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Base Case	\$125	\$215	\$268	\$347	\$459	\$538	\$612	\$661	\$723	\$780	\$848	\$892	\$908	\$926	\$940	\$959	----
Alternative 1	\$125	\$241	\$315	\$422	\$579	\$709	\$832	\$922	\$1,032	\$1,145	\$1,273	\$1,358	\$1,400	\$1,447	\$1,493	\$1,548	\$1,607
Alternative 2	\$125	\$214	\$263	\$340	\$451	\$527	\$600	\$647	\$708	\$763	\$831	\$873	\$892	\$912	\$929	\$951	\$975
Alternative 3	\$125	\$210	\$254	\$326	\$431	\$504	\$572	\$615	\$671	\$722	\$786	\$824	\$842	\$861	\$877	\$898	\$920
Alternative 4	\$125	\$197	\$232	\$287	\$384	\$406	\$450	\$474	\$513	\$544	\$588	\$616	\$624	\$634	\$660	\$651	\$662

TABLE 7-8

FINANCIAL COMPARISON OF THE
BASE PLAN AND THE ALTERNATE PLAN
FOR THE
BASE FINANCIAL CASE

	<u>Base Plan</u>	<u>Alternate Plan</u>
Capital Cost (Millions)		
Current Dollars	2,936	2,963
Inflated Dollars	4,649	4,630
Amount of Bonds (Millions)	4,633	4,589
Net MWRA Revenue Requirement (Millions)		
Fiscal Year 1997	631	663
Fiscal Year 2000	837	832
Typical Homeowner Charges (\$/year)		
Boston - 1997	548	572
- 2000	713	709
Needham - 1997	692	723
- 2000	897	892

managed personnel. MWRA's new treatment facilities will require a significant expansion in the number of staff, the degree of staff skills and the systems used to operate and maintain the existing MWRA facilities.

By 1995, MWRA's facilities will require a staff of 419. At project completion in 1999, a staff of 540 will be needed to operate the facilities. This staffing requirement is more than double the number of existing staff. It is necessary, therefore, that MWRA expand its operational capability concurrently with the building of the facilities.

To prepare for facilities start-up, it is essential that the following activities be initiated in spring 1988 and completed by 1991: (1) development of a preliminary plan of operation; (2) adoption of an organizational structure; (3) preparation of position descriptions, salary levels, benefits packages and hiring schedules; and (4) development of critical management control systems such as maintenance management, safety, emergency response, and septage receiving.

The ability to meet the staffing requirements is complicated by unique local and regional factors including: (1) the Boston Harbor (island) location of the facilities; (2) the difficulty in commuting to the facilities; (3) the strong competition for skilled labor; (4) the lack of a large pool of personnel with wastewater-related skills and experience; and (5) the area's economic climate, particularly the high cost of housing.

These difficulties must be overcome as the proper placement of staff in the required positions is also a critical issue in starting up the treatment facilities in a phased program. The phased approach places a heavy demand on the management staff to ensure that existing personnel are in place and properly trained in a continuing effort to meet the required effluent limits.

A well-conceived and managed recruiting plan, in conjunction with competitive compensation and attention to the provision of special transportation and scheduling accommodations, will assist in meeting the skill and staffing requirements. In addition, the MWRA should evaluate the use of private contractors to operate certain key areas of the recommended facilities. The power and oxygen generation systems are prime facilities that should be considered for private operation. The overall maintenance program should be carefully evaluated to determine whether certain other maintenance tasks could be performed most effectively by highly-qualified and specialized private contractors and equipment vendors.

The MWRA also should use private contractors to conduct or assist in conducting the necessary training programs. An outside contractor could provide training, including setting up the temporary training center, preparing the materials, providing instruction and establishing an evaluation system. An alternative approach is to have treatment plant staff participate as part of the contractor team. This approach would provide a learning experience for plant training staff in the preparation of training materials, lesson plans, visual aids, instruction and organization of future programs.

The final approach for recruiting and training operating staff should be developed by the Authority, in consultation with the Program and Construction Manager (P/CM) and Lead Design Engineer (LE) retained for the Deer Island-related construction effort.

7.5 REQUIRED LEGISLATIVE AND REGULATORY ACTIONS

The legislative and regulatory actions necessary for constructing the recommended facilities pertain to capital financing mechanisms. The two major items are:

- o Elimination, or substantial modification, of the current \$600-million ceiling on the MWRA's borrowing capacity.
- o Obtaining of clear legislative authority to contract, if deemed desirable, with private-sector firms for the simultaneous responsibility of designing, building, and/or operating some or all of MWRA's facilities.

7.6 INTERNAL AND EXTERNAL COORDINATION REQUIREMENTS

Implementation of the facilities plan will require a high level of coordination by the Authority of its own capital projects and management initiatives as well as coordination with other non-MWRA projects. The major related MWRA projects include:

- o MWRA Capital Projects -- a series of capital initiatives designed to upgrade the current treatment capability and to plan future programs for residuals management and reduction of Combined Sewer Overflows.
- o Mitigation Management -- the development of an internal management mechanism to ensure that the Authority will carry out its commitments to Winthrop, Boston, Quincy, and other affected communities. The success of the Deer Island facility and the overall reputation of MWRA will depend largely on its ability to be a "good neighbor" to those who reside near or are affected by its facilities.
- o Infiltration/Inflow (I/I) Management Program -- the development of an Authority program to manage the level of I/I entering the wastewater treatment system, thereby enhancing the performance of the new facilities and diminishing the need to build additional capacity into the system.

The major external coordination requirement is to maintain close contact with the Central Artery/Third Harbor Tunnel project directed by the Massachusetts Department of Public Works (MDPW). Joint planning may uncover opportunities for cooperative projects. Specific areas of cooperation might include: (1) re-use or disposal of excavated material; (2) concrete and labor supply; (3) shared pier facilities; and (4) sequencing of construction bids.

7.7 MITIGATION PLAN

A significant mitigation package was developed as an integral part of MWRA's decision to site the new secondary treatment facilities on Deer Island. Because MWRA is committed to alleviating the impacts associated with the construction and operation of the treatment facilities, the previous mitigation commitments have been an integral part of the facilities planning process.

In the Final Environmental Impact Report on Siting of Wastewater Treatment Facilities for Boston Harbor (FEIR) (MWRA, 1985) mitigation commitments were identified in the following areas:

- o Flow and Growth
- o Operation and Maintenance
- o Odor Control
- o Noise Control
- o Barging and Busing
- o Trucking of Liquid Chlorine
- o Relocation of Deer Island House of Correction
- o Further Measures to be Examined

On February 24, 1988, the MWRA Board approved a "Memorandum of Understanding between the Town of Winthrop and the Massachusetts Water Resources Authority Concerning Certain Affects of the Construction and Operation of Secondary Wastewater Treatment Plant Facilities at Deer Island" (MOU). This document sets forth agreements between MWRA and the Town of Winthrop that further develop the commitments made during the FEIR. The MOU provides mitigation commitments for the following:

- o Environmental Mitigation, including provisions for:
 - Facility Size
 - Odor Control
 - Noise Control
 - Disinfection
 - Separation Area
 - Enforcement Procedure
- o Compensation for Impacts of Construction and Operation on Town Roadways, including provisions for:
 - Transportation
 - Utility Coordination
 - Road Repair
- o Public Safety and Access Considerations, including provisions for:
 - Fire Fighting
 - Transportation of Materials
 - Ambulance Service
 - Emergency Response Plan
 - Access
- o Non-Environmental Mitigation, which provides for:
 - Jobs and Job Training Programs
 - Grant Program

The following summary of the mitigation commitments identified in the FEIR, the MOU and mitigation activities which are proposed in the Secondary Treatment Facilities Plan EIR/EID, provides the current status of the mitigation planning for the project.

Flow and Growth and Facility Size

MWRA has committed to an aggressive program to avoid overloading the new treatment facilities planned for Deer Island, and will not expand the facility size beyond the design flow and loading capacities. MWRA will implement flow management techniques as well as a program to avoid excess pollutant loading. If necessary, future considerations may include flow control structures and satellite treatment plants to minimize peak flows.

Estimates of wastewater flow and pollutant loading have been employed as the basis for wastewater transport, treatment, and outfall project components. In developing the design basis flowrates which have been used for the secondary treatment facilities planning, a sensitivity analysis was performed to assess the magnitude of future growth impacts. The recommended design basis flowrates which are being used for the Secondary Treatment Facilities Planning Project are projected to the year 2020, and are summarized as follows:

<u>Annual Condition</u>	<u>Combined Flowrate</u>
Average flow, low groundwater	390 MGD
Average flow, high groundwater	670 MGD
Annual average flow	480 MGD
Peak flow during storm conditions	1270 MGD

Ongoing MWRA projects which support the implementation of these commitments include the following:

- o Draft I/I management policy;
- o Water conservation program for long range water supply study;
- o Improved water metering program;
- o Studies for wastewater monitoring;
- o Industrial pretreatment program;
- o CSO facilities planning study.

Operations and Maintenance (O&M)

MWRA is committed to improve operations and maintenance. For the Secondary Treatment Facilities Plan, early planning for operation and maintenance has been included:

- o A preliminary plan for the Maintenance of Plant Operation during Construction has been prepared. It describes the transition from existing to new facilities, incorporates consideration of permit discharge compliance, plant access, mitigation requirements and interim facilities, if needed.

- o A preliminary plan of operation has been included to identify the additional or unique O&M requirements of the recommended facilities, including staffing and associated special training needs, and estimated budget considerations.

Odor Control

MWRA is committed to the construction of a facility that will control odors to eliminate detectable odors offsite, to protect the public health, and to minimize, to the extent feasible, objectionable odors onsite. Criteria for evaluating the potential for odors and other air emissions associated with alternative plans were considered in all secondary facilities planning project components.

In the MOU, no detectable odor off-site has been defined as "...no distinguishable odor associated with the Deer Island facilities detectable at the nearest residential location when one part of ambient air is diluted in one part odor-free air."

If odor requirements are not met at any time, in accordance with the MOU, MWRA will repair the malfunctioning facilities that control air emissions, to bring them into full compliance immediately.

Proposed mitigative measures for odor control include the following:

- o Conceptual site planning, in general, has located treatment operations having a high potential for odor production in the southern portions of Deer Island; facilities for residuals handling are located on the southernmost portion of Deer Island.
- o For early site preparation, the excavation and disposal of the grit and screenings will be performed during the cooler months (November through March) to minimize odors.
- o The secondary treatment facilities plan includes air emissions modelling and impact evaluations performed in accordance with DEQE requirements, which support a facility design protecting public health. These evaluations have recommended the covering of grit chambers, primary clarifiers and aeration tanks; and the treatment of off-gases to remove both odors and volatile organic compounds. A two stage treatment system, consisting of wet scrubbing and carbon adsorption, is recommended for controlling air emissions.

Noise Control

MWRA has committed to comply with all legal standards and has set a noise abatement goal that goes beyond simply adhering to applicable codes. MWRA will examine the need for noise abatement throughout the design, construction and operation of the facility to avoid adverse noise impacts. MWRA will also establish an acoustic review board and will solicit community involvement in the noise control program.

THE UNIVERSITY OF CHICAGO
DIVISION OF THE PHYSICAL SCIENCES
DEPARTMENT OF CHEMISTRY

REPORT OF THE
COMMISSIONERS OF THE
UNIVERSITY OF CHICAGO
FOR THE YEAR 1900

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The MOU has limited noise that would be transmitted to the Winthrop town line as a result of operation of the facility, to a maximum of 36 dBA during both daytime and nighttime. During facility construction, nighttime (7:00 p.m. to 7:00 a.m.) noise shall not exceed 36 dBA.

The MOU limits daytime noise from construction on weekends and federal holidays to 36 dBA, transmitted to the Winthrop town line. However, the MOU provides for a detailed assessment of the noise impacts to be performed if Saturday morning construction is required to meet the court schedule. Upon completion of that assessment, the Town of Winthrop and MWRA will agree to a resolution that may include jointly petitioning the court for extension of its milestones or extending weekday hours of construction. Should Saturday morning construction be demonstrated to be necessary, an appropriate noise level will be established.

The ongoing development of noise control mitigative measures for use during construction of the secondary treatment facilities has resulted in recommendations for several mitigating concepts to date, including:

- o At Deer Island, a noise barrier berm would be constructed at the northernmost portion of the island to control off-island noise from landfilling and other noise-producing operations.
- o Various mitigative techniques such as the use of quieted bulldozers, and pile driving shrouds would be employed to control off-island noise.

For facility operation, noise controlling and mitigating measures which are proposed include the following:

- o The designs of major buildings would include provisions for the application of acoustical absorptive materials.
- o Building ventilation openings would either be oriented away from noise-sensitive receptors, and/or be silenced. Ventilation fans will be silenced.
- o All exterior motors and most motors located in buildings would be of a quieted design.
- o The gas turbine power generating equipment would include intake and exhaust silencing, and an acoustical enclosure.
- o Compressors would be provided with intake and discharge silencers.
- o Above-ground, exposed piping in the cryogenic plant would be provided with acoustical lagging. The cryogenic plant would include molecular sieve prepurifiers.

During the design and construction of the facilities on Deer Island, dozens of pieces of equipment that meet these noise standards will have to be purchased; noise mitigation equipment such as silencers will have to be specified and purchased; compliance with the noise limitations during construction and operation will need to be monitored. Recommendations which provide a preliminary Noise Control Plan, consist of the following key elements:

- o Development of an Acoustical Model for the Site
- o Acoustical Criteria for Equipment
- o Noise Control Engineering
- o Project Tracking System for Equipment
- o Noise Specifications
- o Comparison of Bids and Recommendations for Purchase
- o Commitment Tracking
- o Construction and Operational Noise Monitoring
- o Investigation of Noise Complaints

Barging and Busing

The MOU has provided significant commitments that provide over-water and busing transportation for construction workers, and over-water transportation of all but contingency allowances of construction equipment and materials that will mitigate traffic impacts to Winthrop. Currently, there is an assumption that traffic will be mitigated in Quincy utilizing similar means. Commitments that provide for ferrying, barging, and busing are summarized below; commitments that are specific to over-land traffic are summarized in the next section on Traffic.

For the construction of all facilities, except piers and early site preparation, MWRA will provide the capacity to ferry a minimum of 50 percent of the daily construction work force. The MWRA will attempt, during most construction periods, to ferry more than 50 percent of the daily workers.

For the construction of all facilities, except piers and early site preparation, all construction personnel not ferried, and who live outside of Winthrop and East Boston, will be bused to Deer Island from satellite parking areas to the north and east of Boston. It is assumed, that following construction of piers on Nut Island, construction workers required for the Nut Island facilities construction will be ferried.

A good faith effort will be made to implement busing to the maximum extent feasible during pier construction and early site preparation.

The MWRA will make a good faith effort to implement the recommendations of the facilities plan relative to providing satellite parking, busing, and ferrying facilities for operational personnel.

For the construction of the on-island piers, water transportation will be used for the movement of concrete and aggregate materials. Following completion of the on-island piers (November, 1989), only water transportation will be used for the movement of construction equipment and materials, except for a maximum contingency level of over-land trucks as described in the following section.

Traffic

The MOU will use the existing Fast-Track truck route only; any additional route will be subject to approval by the Town of Winthrop. Traffic mitigation commitments identified in the

Memorandum of Understanding (Fast-Track Construction), executed February 3, 1986, and Construction Mitigation Provisions contained in Specifications for Fast-Track projects, will be implemented into the period of pier construction. These provisions may be periodically reviewed to determine if they are applicable relative to current conditions.

Following completion of pier construction, MWRA will limit construction truck traffic to Deer Island to no more than eight, two-axle truck, round trips per day. Operation and maintenance truck traffic to Deer Island will be limited to six round trips per day, following completion of pier construction.

For paved streets disturbed by construction of the new water main and the new gas main, MWRA will repave the streets curb-to-curb, including restoration of the road base as necessary. For rights-of-way on streets that are not paved, the rights-of-way will be restored to preconstruction conditions, including full revegetation as appropriate.

For the truck route used to support the Fast-Track improvements and the construction of the new treatment facilities prior to completion of the piers, an independent consultant will be engaged by MWRA to prepare a report describing all necessary repairs to the truck route upon completion of the piers, and describing associated costs. The MWRA will provide payment to the Town of Winthrop for the estimated road repairs.

The EIR/EID recommends specific additional mitigation measures, which will improve existing traffic conditions in Winthrop, and will control impacts to traffic during facility construction. Activities to implement these mitigation measures have been recommended, if approvable, by the DPW, and are as follows:

- o Installing traffic signals and providing phasing to existing signals;
- o Re-stripping lanes, where needed, to indicate turning direction;
- o Eliminating on-street curb parking for three spaces at certain intersections.

Utility Coordination

The MWRA plans to install a new water main, a new gas main, and a temporary electrical power cable through the Town of Winthrop to serve the needs of the new treatment facilities. In accordance with the MOU, MWRA will provide the following benefits to the town, associated with these new utilities:

- o New Water Main Construction - A new water main will be constructed from MWRA's Northern High Distribution System (NHDS) at the Revere/Winthrop Town Line to Deer Island. MWRA will prepare a preliminary engineering study of the new main to assess the routing, size, storage needs, points of connection to the Winthrop system, metering and any improvements needed in the NHDS. Both interim and long-term improvements will be identified. The new storage and transmission/distribution line will jointly provide for the long-term needs of Deer Island and Winthrop, as mutually agreed to by the Town and MWRA.

- o New Gas Main - A new gas main will be constructed to serve the new treatment facilities on Deer Island. To the maximum extent possible, the new gas main will be constructed in the same right-of-way as that selected for the new water main, and will be constructed at the same time as the water main. Appropriate connections will be made to the gas distribution system of the town, including any necessary metering. The MWRA will prepare a preliminary engineering study of the proposed new gas main to assess the routing, size, points of connection to the town's system, and proposed metering.
- o Interim Power Supply - An interim electrical power supply cable will be installed to serve Deer Island until the long-term power supply facilities are operational, at which time any overhead interim power supply cable will be removed. The design for interim power supply cable will consider both the aesthetics and the disruption to the town, associated with its construction. A preliminary design for the interim power supply cable will be submitted to the town for its approval, prior to the award of a construction contract.

Trucking of Liquid Chlorine

The MWRA has committed to cease the trucking of liquid chlorine through Winthrop as soon as the conversion to sodium hypochlorite disinfection facilities and the availability of pier access facilities is complete. Both are scheduled to be completed by October, 1989.

After the conversion to sodium hypochlorite has been completed, MWRA will use that method of disinfection exclusively.

In conjunction with the sodium hypochlorite disinfection facilities, if any dechlorination is required, MWRA agrees to use sodium bisulfite or any other dechlorination agent that is not a hazardous substance under MGL c. 21C and 21E.

Public Safety and Access Considerations

Fire Fighting

The MWRA plans to establish its own fire department for the Deer Island facilities. However, until this department is established, MWRA will rely on the Town of Winthrop's Fire Department for its first line of protection. The MOU provides for the following:

- o Payments to the Town of Winthrop for fire fighting services (based on the continuation of the present role of the Boston Fire Department as part of the standard box alarm response to Deer Island);
- o Establishing a foam bank on Deer Island;
- o Providing certain rescue and personal safety equipment and tools to the Town of Winthrop;

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- o Notification of the Town of Winthrop Fire Chief of all inspections of construction and facilities by State Public Safety Department inspectors.

Transportation of Materials

The MWRA will notify appropriate Town of Winthrop officials in advance if there is ever a need to transport hazardous materials (as defined in MGL c. 21C and 21E) through the town, to or from the treatment plant.

Ambulance Service

The MWRA will contract with a private ambulance service for ambulance service to the treatment plant or, if advantageous to both parties, will bid jointly with the Town of Winthrop for ambulance service.

Emergency Response Plan

The MWRA will consult with the local hospital and formulate an emergency response plan acceptable to the Town of Winthrop that will be appropriate to handle anticipated emergencies at the treatment plant.

Access

The MWRA will provide reasonable access to the facility upon request by Town of Winthrop officials, and will provide immediate access to emergency personnel. A reasonable schedule of tours of the facility will be provided to the residents of the Town of Winthrop.

Non-Environmental Mitigation

The MOU provides for both jobs at the treatment plant and job training programs, that will be available and accessible to Winthrop residents.

A \$24,000,000, 13-year grant program is also provided for the Town of Winthrop, to create a public benefit programs and to mitigate the impact of the facility on the operation of town government and on the lives of affected residents. The Town of Winthrop may utilize grant funds for projects where the public benefit that results is directly related to the impacts or other effects created by the facility construction, operation, and maintenance.

One of several examples provided in the MOU illustrating the use of the grant program funding, is the provision for rehabilitation and retrofitting of privately owned properties to reduce noise impacts and promote soundproofing. This program would be limited to those homes where the DEQE 10 dBA limit is projected to be exceeded due to Deer Island construction, as shown in Volume III, Appendix D, Figure D-4. The MWRA will actively participate with Winthrop in seeking federal and/or state funding for soundproofing out to the limit of 6 dBA (Northern edge of Cottage Hill) resulting from Deer Island construction.

Relocation of Deer Island House of Correction

MWRA has determined that the Deer Island House of Correction must be relocated; as a mandatory mitigation measure. All secondary treatment facility planning is predicated on the requirement for the earliest relocation of the House of Correction. If relocation is delayed beyond 1989, mitigative measures would be required relative to ongoing House of Corrections operations, which may include:

- o Relocation of security fencing, the prison recreational area, the guardhouse, and the parking lot;
- o Potential mitigative measures for controlling noise at the prison, such as providing noise barrier fencing in designated areas.

Separation Area

As an integral part of MWRA's commitment to mitigate both noise and odor impacts on the Town of Winthrop, it will maintain a separation area of berms and open space between the constructed facilities and the Town. The location and elevation of these areas is described in Volume III of the EIR/EID. The separation area will be maintained for the operating life of the facility.

Further Measures to be Examined

EOEA, in its final certification, recommended that MWRA consider earlier implementation of certain additional measures. Within the facilities plan, MWRA has examined other suggestions such as the concept of the "sewer bank," the utilization of satellite plants, additional flow measurements, odor panel formation, odor monitoring, and formation of an acoustic review board.

Additional mitigative measures that have been proposed in the preliminary facilities planning documents include the following:

Historical and Archaeological Resources (subject to approval in a Memorandum of Agreement between the Massachusetts Historical Commission (MHC), EPA, and MWRA):

- o Temporary protective measures (e.g., fencing, limitation of construction activities, etc.) would be provided for historic structures that will not be demolished as a result of site development.
- o Documentation for the Historic American Building Survey would be performed for historic structures that will be demolished (i.e., the Hill Prison and the Farmhouse).
- o The Pumping Station and Superintendent's House would be reused as part of the STFP, and would require building renovation for both, and in the case of the Superintendent's house, relocation.

- o The New Resthaven Cemetery would be preserved by the addition of fill material which would, in turn create visual and noise barrier landforms. Provision for erecting permanent boundary markers, formal documentation, and relocation of the existing concrete cross will be considered.

Erosion and Sedimentation Control:

- o Surface runoff will be diverted away from areas under construction, by using hay bales and/or diversion ditches.
- o Surface runoff from areas under construction will be directed to holding ponds, silt traps, etc.
- o Temporary stabilization of graded areas by seeding, tacking, or mulching will be provided until permanent cover is established.
- o Sprinkling trucks will be used, as necessary, to control fugitive dust (windborn erosion) associated with earthmoving activities.

Terrestrial Ecology:

- o Consideration will be given to providing habitat areas on Deer Island landforms that would be suitable for visiting raptors. Habitat areas could consist of appropriate vegetation and perching/nesting structures.

